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VOL. CXXXV.—No. 3511] LONDON: FRIDAY EVENING, APRIL 13, 1923 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY IRELAND POST 1s. 2d.

PUBLIC NOTICES

Executive Engineer Required by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT for two tours of not less than twelve nor more than eighteen months, with possible extension. Salary £480-£30-£720-£40-£920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages. Liberal leave in England on full salary.

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Dean: Professor T. B. ABELL, O.B.E., M.Eng. R.C.N.C., Ret., M. Inst. N.A.

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The Prospectus of the Faculty may be obtained on application to the undersigned.
2099 EDWARD CAREY, Registrar.

Bombay, Baroda, and Central India Railway Company.

The Directors are prepared to receive up to Noon on Wednesday, 2nd May, TENDERS for the SUPPLY of: WHEELS AND AXLES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary.

Offices: 91, Petty France, Westminster, S.W. 1.
9th April, 1923. 2114

The Great Indian Peninsula Railway Company.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely:—

	Fee for Specification.
1. LOCOMOTIVE BOILERS	£1
2. STEEL WORK FOR BRIDGES	7s. 6d.
3. CARRIAGE DOOR HANDLES, HINGES, &c.	7s. 6d.
4. MISCELLANEOUS ARTICLES AND MATERIALS	10s.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Locomotive Boilers," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 24th April, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE, Secretary.

Company's Offices,
48, Copthall-avenue, E.C. 2.
London, 11th April, 1923. 2167

The Madras and Southern Mahratta Railway Company, Limited.

The Directors are prepared to receive TENDERS for:
(i.) 2000 STEEL TYRES FOR CARRIAGES AND WAGONS.
(ii.) 648 STEEL TYRES FOR ENGINES AND TENDERS.

in accordance with the specifications, which may be seen at the offices of the Company. The charge for each specification is One Guinea, which will not be returned. Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 1st May, 1923, and marked "Tender for Tyres for Carriages and Wagons," or as the case may be.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices:
25, Buckingham Palace-road, Westminster, S.W. 1.
10th April, 1923. 2152

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

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Ball and Roller Bearings for Locomotives.

Institution of Naval Architects—No. IV.

PUBLIC NOTICES

County Borough of Burton-upon-Trent.

BURTON BRIDGE WIDENING, CONTRACT NO. 1.

The Corporation of Burton-upon-Trent invite TENDERS for the WIDENING of BURTON BRIDGE across the valley of the River Trent in FERRO-CONCRETE on the Hennebique system, from substantial and responsible contractors who shall be authorised to execute ferro-concrete construction on that system.

The bridge consists of six arches, 45ft. span, and twenty-six arches of 26ft. span, the total length being about 1200ft., and the width of the proposed widening is 20ft., with a triangular extension at the east end averaging 45ft. in width.

Drawings may be seen, and specifications, conditions of contract, bills of quantities, and forms of Tender may be obtained at the office of the undersigned on and after the 16th April, 1923, on deposit of a Ten Pound Bank of England note, which will be returned after receipt by the Corporation of a bona fide Tender with schedule of prices filled up and bill of quantities fully priced in.

No Tender will be accepted from any person who pays his employees (whether artisans or labourers) less than the standard rate of wages paid in this borough, or who does not conform to the hours and conditions of labour generally recognised as fair in each branch of industry affected, and clauses to ensure compliance with this regulation are inserted in the conditions of contract.

The Corporation do not bind themselves to accept the lowest or any Tender.

Tenders, properly endorsed, must be delivered at my office not later than 5 p.m. on Tuesday, 1st May, 1923.

GEORGE T. LYNAM, M. Inst. C.E., Borough Engineer and Surveyor.

Town Hall, Burton-upon-Trent,
29th March, 1923. 2055

Royal Burgh of Kirkcaldy.

ELECTRICITY WORKS, VICTORIA-ROAD.

The Provost, Magistrates and Council invite TENDERS for the following WORK:—

SPECIFICATION No. 16.—HIGH AND LOW-TENSION FEEDER CABLES.

SPECIFICATION No. 18.—COOLING TOWER.

A copy of either specification and its drawings can be seen at and obtained from the offices of Messrs. Kennedy and Donkin, 8, Broadway, Westminster, S.W. 1, on and after Saturday, April 14th, 1923, upon payment of a deposit of £2 2s. (cheque, postal or money order). An additional copy of either specification can be obtained upon payment of a deposit of £1 1s. These deposits will be returned after the receipt of a bona fide Tender, and on the return of the specification.

Tenders, on the prescribed form, enclosed in sealed envelopes and addressed on the outside "Electricity Supply, Tender to Specification No. 16," or "Electricity Supply, Tender to Specification No. 18," must be delivered at the office of the undersigned not later than 10 a.m. on Tuesday, May 1st, 1923.

The Council do not bind themselves to accept the lowest or any Tender.

W. L. MACINDOE, Esq.
Town Clerk's Office, Kirkcaldy,
April, 1923. 2123

Tottenham District Council.

(AMENDED ADVERTISEMENT.)

TO MANUFACTURERS OF CLINKER CRUSHING AND SCREENING PLANT.

The Council invite TENDERS for certain PLANT in connection with CLINKER CRUSHING at their Destructor Works. This plant is to include Crushers, Elevator, Magnetic Separator, Screen, Storage Bins, &c. Further particulars may be obtained on application to the Engineer of the Council. Tenders must be delivered to the undersigned, in sealed envelopes, endorsed "Tender for Clinker Plant," not later than Twelve Noon on TUESDAY, 17th APRIL, 1923.

Dated this 10th day of April, 1923.

REGINALD C. GRAVES, Clerk and Solicitor of the Council.

Town Hall, Tottenham, N. 15. 2139

PUBLIC NOTICES

Department of Public Works, Sydney, 31st January, 1923.

SYDNEY HARBOUR BRIDGE TENDERS—EXTENSION OF TIME.

Tenders are Invited by the Government of New South Wales for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of a CANTILEVER BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1600ft. in the clear, centre to centre of main piers, and a length of main bridge 3600ft. centre to centre of anchor piers. The total length of main bridge and approach spans included in Tender is 3810ft.; also an ALTERNATIVE TENDER for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of an ARCH BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1650ft. in the clear, centre to centre of bearings. The total length of main bridge and approach spans included in Tender is 3770ft. Either bridge is to provide for four lines of railway, six lines of vehicular traffic, and footway accommodation.

Copies of specification, including plans, technical information, general conditions, and Tender forms, may be obtained by bona fide tenderers on application to the Under-Secretary for Public Works, Sydney, or to the Agent-General for New South Wales, Australia House, The Strand, London; the Minister of Railways and Canals, Ottawa; the Australian Trade Commissioner in the United States, New York; or the Bureau of Foreign and Domestic Commerce, Washington, D.C., United States.

Tenders, the time for which has been extended, must reach the Under-Secretary for Public Works, Sydney, New South Wales, not later than 30th November, 1923.

R. T. BALL, Minister for Public Works and Railways.

2085

City of Chichester.

ENGINEER-IN-CHARGE AND SECOND ENGINEER OF WATER PUMPING STATION, FISHBOURNE.

The Corporation of Chichester REQUIRE an ENGINEER to Take Charge as Foreman and Chief Mechanic of the Suction Gas and Steam Pumping Plant at the Waterworks Pumping Station, Fishbourne, near Chichester; £3 5s. per week, with house and coal.

SECOND ENGINEER also REQUIRED at same Pumping Station; £2 5s. per week, with house and coal.

Any further information desired may be obtained from the City Engineer and Surveyor, 62, South-street, Chichester.

Applications, with full particulars of experience and copies of testimonials, endorsed "Engineer," to be sent to me by 30th April, 1923.

J. W. LOADER COOPER, Town Clerk.
Chichester. 2107

M.A.B.—The Board Invite APPLICATIONS for the APPOINTMENT of a SECOND-CLASS DRAUGHTSMAN at the Mead Works, Carnwath-road, Fulham, S.W. 6 (Repair Works for Motor Vehicles). Salary £150 by £10 to £180 plus Civil Service bonus, at present £94 12s., on the commencing salary. Minimum age 25 years, maximum 35.—For application form, with full particulars, apply (enclosing stamped addressed envelope) to the ACTING CLERK to the BOARD, Victoria Embankment, London, E.C. 4. Completed forms to be returned by 10 a.m. on 16th April, 1923. 2117

TO THE CONTRACTOR (Name Unknown) who the other day phoned Regent-street for name and address of Engineer who recently surveyed Piccadilly-circus. PLEASE WRITE to E. MOUL, Hollybank, Woking. P7254

SITUATIONS OPEN

WANTED by Well-known Internal Combustion Engine Manufacturers, Competent and Experienced DESIGNER of High Compression Solid Injection Cold Starting Heavy Oil Engine. Only applicants with the highest qualifications should apply.—Address, giving full particulars of career to date and state approximate salary required, 2142, The Engineer Office. 2142 A

WANTED, for Egypt, ASSISTANT MECHANICAL ENGINEER, British, public school education, gentleman, thorough general workshop experience essential, age 29-34, unmarried preferred; salary £540-£600.—Write, DREDGING CO., 35, Sharia Wabour el Miah, Cairo, Egypt. P7192 A

WANTED, SALES MANAGER, with Extensive knowledge of Woodworking Machinery, London district. State qualifications for position.—Address, 2120, The Engineer Office. 2120 A

WANTED, SALESMAN, Having Experience in Woodworking Machinery, Manchester district. State experience, &c.—Address, 2119, The Engineer Office. 2119 A

ASSISTANT ENGINEER, Sound Mechanical and Electrical experience; competent to take complete charge of all Surface and Underground Equipment and Machinery, including modern Power Station, A.C., on Gold Mine, Tropical Africa.—Address, stating age, experience, with copies testimonials, 2149, The Engineer Office. 2149 A

HEATING ENGINEER.—LONDON MANAGER REQUIRED, primarily for Heating Department. Applicants must be fully competent to design all systems of Heating, Ventilating, and Drying Plants and have personal connection with architects and consulting engineers, and be fully competent to supervise and control staff and workmen. Applicants must be of strict commercial integrity and good appearance. A lucrative and progressive income is offered.—Apply in full confidence, giving full information as to experience, to Managing Director, DILWORTH and CARR, Ltd., Preston. P7223 A

IRON and BRASSFOUNDERS Should Obtain the "Foundryman's Educator on Mixings of Metals, Alloys and Iron Productions." We are helping others. Why not help you to secure better positions. F.F. 8s.—Harefield Hall, Heywood, Lancs. P7300 A

MANUFACTURING ENGINEERING COMPANY REQUIRE REPRESENTATIVE in London district. Must have established business, good connection, and be of good address, able to introduce business; Steam Engines, Sawing Machinery, and General Engineering Work.—Address, 2105, The Engineer Office. 2105 A

REQUIRED AT ONCE, REINFORCED CONCRETE ENGINEER, thoroughly experienced in Design and Estimating for all classes of Ferro-concrete Structures; University graduate preferred.—Address, giving full particulars, salary required and earliest date of commencement, P7264, The Engineer Office. P7264 A

SECRETARY (Male, Full-time) REQUIRED by the Leicester District Engineering Trades Employers' Association; qualifications, age (not under 35) and salary to be stated.—Applications to be sent to 39, London-road, Leicester. P7262 A

TRACK INSPECTOR REQUIRED for CHINESE GOVERNMENT RAILWAYS on a 3 years' agreement; must be a fully qualified platelayer, used to flat-bottomed rails, and have had previous permanent way experience with first-class railway. Age 30 to 35, preferably unmarried.—Applications by letter only, stating fullest particulars with copies testimonials, to "C. L.," c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, London, E.C. 4. 2140 A

WORKS SUPERINTENDENT WANTED, of Proved executive and organising ability, for Electrical Switch and Control Gear Factory, South Midlands. Sound experience of modern production methods and processes essential; electrical knowledge and experience of design an advantage.—Fullest particulars, in chronological order, with salary and age, to Box 100, Potter's Advertising Offices, Imperial House, Kingsway, London, W.C. 2. 2116 A

WANTED, a DRAUGHTSMAN, with Experience in the design of Semi-Diesel Oil Engines.—Address, stating age, experience and salary required 2146, The Engineer Office. 2146 A

A LARGE Industrial Company in Cheshire REQUIRE the SERVICES of a HEAD DRAUGHTSMAN, age 30-35, to Take Charge of Mechanical Engineering Drawing-office under Chief. Applicants must possess a sound mechanical training with practical Works Experience and be accustomed to modern drawing-office methods of Preparing Plans for new and alteration work. He must be able to prepare specifications and estimates and generally run his office on modern and efficient lines. A first-class knowledge of Power Transmission, Pipe Lay-outs, Conveyor and Elevator Work and Engineering Costs is essential. Replies must state fully age, where trained and since employed, kind of work engaged upon, and salary required.—Address, 2121, The Engineer Office. 2121 A

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SITUATIONS OPEN (continued)

DRAUGHTSMAN ESTIMATOR REQUIRED for Elevating and Conveying Machinery. Works near London. Only those with actual experience need apply. Send full particulars.—Address, 2166, The Engineer Office. 2165 A

DRAUGHTSMEN WANTED, Thoroughly Experienced in the Design of—
(A) Steel Bridges and General Construction Work.
(B) Steel Caissons and Gates for Dock Entrances.
Applications, stating age, salary required, and full particulars of training and experience and when at liberty, to be addressed to the CHIEF ENGINEER, Great Western Railway, Paddington, W. 2. 2180 A

FIRST-CLASS DRAUGHTSMAN REQUIRED, Thoroughly experienced in all types of Crane Design. No others need apply.—Apply, stating full particulars and salary, JOSEPH BOOTH and BROS., Ltd., Rodley, Leeds. 2169 A

SWITCHGEAR DRAUGHTSMEN.—First-class MEN WANTED by Firm in N.W. London, with experience in Design and Lay-out of Up-to-date Switchgear. Only men with sound practical and technical training need apply. Good openings for really first-class men.—Address, stating age, experience, and salary required, 1988, The Engineer Office. 1988 A

MACHINE SHOP FOREMAN REQUIRED for CHINESE GOVERNMENT RAILWAYS on three years' agreement. Previous experience in Machine and Smiths' Shop of First-class English Railway essential; age 30 to 35.—Applications by letter only, stating full particulars of experience, qualifications, age, &c., accompanied by copies testimonials, to "A. T.," c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, London, E.C. 4. 2141 A

SITUATIONS WANTED

ADVERTISER, Qualified Mechanical Engineer-draughtsman (34), WANTS POST as Assistant Works Manager or Engineer; 10 years' experience in steam, electrical, and I.C. plant; held similar appointments at home and abroad; lately engaged on asphalt manufacture; salary £460 to start; good refs., war service in R.E.s.—Address, P7163, The Engineer Office. P7163 B

ADVERTISER SEEKS APPOINTMENT where experience of light constructional work, overhead runways, estimating, would be an advantage; also used to following up enquiries, interviewing customers, measuring up, &c. Patentee of flexible and portable crane runway.—Address, P7234, The Engineer Office. P7234 B

BOILERMAKER, Thoroughly Practical Knowledge boiler inspecting, boiler repairs, marking off, electric welding, &c.; technical knowledge, boiler design, care and management of boilers, &c.—Address, P7265, The Engineer Office. P7265 B

CIVIL ENGINEER, Located London, 20 Years' active experience on public works, including 9 in U.S.A., embracing surveys, reports, designs and in charge of construction, DESIRES TECHNICAL APPOINTMENT with financial corporation or would Represent Non-resident American having British interests.—Address, P7244, The Engineer Office. P7244 B

CONSTRUCTIONAL and MAINTENANCE ENGINEER (34) DESIRES POST. Works Manager or Works Engineer; excellent experience, shop and D.O., condition, steam, gas, furnaces, buildings and chemical plant; good organiser and used to control; keen and energetic.—Address, P7246, The Engineer Office. P7246 B

ENGINEER, Aged 29, First-class Capacity in the electrical welding machinery trade, manager of the oldest manufacturing works of this speciality on the Continent (inventor of the most modern welding machines, highly approved in practice, own patented inventions), SEEKS POSITION as MANAGING or WORKS ENGINEER in established English manufacturing works.—Offers to M.B. 6884, c/o Rudolf Mosse, Munich. P7223 B

ENGINEER, Young, REQUIRES APPOINTMENT; first-class fitter and turner, gas, steam and petrol engines, also general repair work, maintenance or construction.—Address, P7257, The Engineer Office. P7257 B

ENGINEER (32), at Present Outside Manager important continental ship-repairing firm, SEEKS CHANGE; fluent technical French, estimating, supervising costs, good organiser and disciplinarian; consider any offer, home or abroad, where good general engineering and business experience would be useful. First-class references.—Address, P7230, The Engineer Office. P7230 B

ENGINEER (Young), A.M.I.M.E., WOULD ACCEPT SMALL SALARY to gain wider experience; 5 years' apprenticeship general engineering, then motor work; excellent refs.—Address, P7240, The Engineer Office. P7240 B

ENGINEER (33) DESIRES POST. Practical (foundry to D.O.) and technical; late shop supt. and assist. tech. engr.; experienced pumping engines, I.C. engines, speciality trades and physical testing of metals; good organiser, ability for costing and laying-out of operations; first-class refs.—Address, P7260, The Engineer Office. P7260 B

ENGINEER (English), Experienced in Patent Law and practice, sound knowledge of technical and chemical German, DESIRES SUITABLE SITUATION, whole or part-time, London or provinces.—Address, P7211, The Engineer Office. P7211 B

ENGINEER, Excellent Long-service Record as Foreman, draughtsman and works manager with general engineers and ironfounders, SEEKS RESPONSIBLE POSITION; well-educated, energetic, successful organiser and controller of labour.—Address, P7266, The Engineer Office. P7266 B

ENGINEER, First-class Board of Trade Certificate, SEEKS SHORE APPOINTMENT in any capacity; disengaged end of April; age 30; excellent references; total abstainer.—Address, P7233, The Engineer Office. P7233 B

ENGINEER, M.I. Mech. E., Now Representing well-known firm in the London area, DESIRES similar or other suitable POST; 40 years' practical and commercial experience, including 16 years' works and general management.—Address, J., 29, Westbourne-gardens, W. 2. P7210 B

ENGINEERING.—EMPLOYMENT MANAGER and HEAD RATE FIXER SEEKS RE-ENGAGEMENT. Last position involved all labour questions, Federation correspondence and representation, workmen's compensation, factory records and inspection, welfare and ambulance arrangements, apprentice education, all piecework, staff bonuses, &c., engagements, discharges, references, &c., works and staff; over 4000 employed; 40 productions; trained engineer, highest references; 17 years with last employer.—H., 4, Summerville-terrace, Humphrey-lane, Urmston, Manchester. P7231 B

INSPECTION DEPT.—Keen MAN, 16 Years' Exp., thorough knowledge modern machine shop and inspection methods (mechanical and electrical); Vickers, Rolls-Royce and Vauxhall experience.—Address, P7258, The Engineer Office. P7258 B

JOHN HEATH, Cudworth Lodge, Newdigate, Surrey, having 21 years' experience of interchangeable production as chief designer, purchaser and works superintendent, &c., accustomed to control large staffs, OFFERS SERVICES in similar capacity or as London Representative. Inquiries solicited. P7227 B

MECHANICAL ENGINEER WANTS RE-ENGAGEMENT as MAINTENANCE ENGINEER or FOREMAN MILLWRIGHT; good all-round shop experience; good refs.—Address, P7270, The Engineer Office P7270 B

SITUATIONS WANTED (continued)

MECHANICAL ENGINEER (25), G.I. Mech. E., over 7 years' practical experience, including 6 years' apprenticeship, 3 years engineering college, REQUIRES a POSITION in engineering firm with good future prospects.—Address, P7229, The Engineer Office. P7229 B

PUPIL, Having Finished Three Years' Time at Messrs. Thornycrofts, Ltd., Basingstoke, REQUIRES ANY POST ABROAD.—Write, Box 8629 Hyam's Advertising Agency, 10, Essex-street, Strand, London, W.C. 2. 2158 B

SECRETARY ACCOUNTANT DESIRES ENGAGEMENT, any capacity. Practical experience of engineers and machinists costing and stores organisation; thoroughly capable of installing complete system; practical workshop experience, accustomed to working drawings. Will accept position home or abroad.—Address, P7224, The Engineer Office. P7224 B

STRUCTURAL STEELWORKER (25), 3 Yrs. D.O., 6½ yrs. shop and outside erecting, good education and references, SEEKS RESPONSIBLE SITUATION, home or abroad.—Address, P7267, The Engineer Office. P7267 B

TWO-STROKE ENGINES. — ENGINEER-DESIGNER, with 16 years' experimental and research experience; highest references as designer of successful A.C. and W.C. two-stroke engines.—"DEUX TEMPS," 147, Brookhill-road, Ward End, Birmingham. P7241 B

WORKS or GENERAL MANAGER. Successful organiser, with many years exceptionally wide experience in both capacities and as chief engineer, WANTS ENGAGEMENT, general engineering, large weldless tubes, hydraulic forging, steel plant and manufacture; commercial experience.—Address, P7225, The Engineer Office. P7225 B

DRAUGHTSMAN (London District) SEEKS SITUATION; 16 years' good all-round engineering experience in shops and drawing-office.—Address, P7216, The Engineer Office. P7216 B

ENGINEER DRAUGHTSMAN (36) WANTS POST. Ten years' supervision of department and D.O., general engineering, foundry, railway experience; first-class references.—Address, P7245, The Engineer Office. P7245 B

REQUIRED IMMEDIATELY (a) INSTRUMENT DRAUGHTSMEN with experience in highest class Camera Work and good workshop and technical training; (b) SENIOR DRAUGHTSMEN with at least six years' experience in Telephone, Telegraph or Wireless Work; (c) JUNIOR DRAUGHTSMEN with not less than three years' Drawing-office experience in Telephone, Telegraph or Wireless work. Preference will be given to ex-Service men.—Write, giving full particulars of age, training, experience, and salary required, to SECRETARY (S.2), Air Ministry, Adastral House, Kingsway, W.C. 2. 2164 A

YOUNG MAN (21), with 4 Years' Apprenticeship to millwrighting, 9 months' D.O. experience, also technical school training, SEEKS POSITION as JUNIOR DRAUGHTSMAN, London district preferred.—Address, P7235, The Engineer Office. P7235 B

YOUTH (Age 17) DESIRES SITUATION in Engineer's Drawing-office; just finished 3 years' technical training; good scholar.—Write, E. W., The Firs, Fernlea-road, Balham. P7248 B

MACHINE SHOP FOREMAN, 38 Years of Age, REQUIRES POSITION, same capacity, home or abroad.—Address, P7228, The Engineer Office. P7228 B

ENGINEER (Working) SEEKS SITUATION. Good all-round experience, fitting, turning, charge of plant; 1st Class B.O.T. Certificate.—FRANKLIN, 3, Riverdale-road, Twickenham, Middlesex. P7268 B

ENGINEERS' FITTER SEEKS SIT; Age 25; 11 yrs.' exper. motor, general, millwrighting; anything considered.—BONE, 7, Ebor Cottages, S.W. 15. P7253 B

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The Lakeside Electric Power Station at Milwaukee.

No. I.

NOTABLE among the many recent American electric generating stations of large size and interesting equipment is the new Lakeside station at Milwaukee of the Milwaukee Electric Railway and Light Company. The city of Milwaukee, which has a population of about 500,000, is on the west shore of Lake Michigan, and lies about a hundred miles north of the larger city of Chicago. The new station is intended for an ultimate capacity of 200,000 kilowatts, and has the unusual feature of having been specially designed for the use of pulverised coal as fuel. From experience with this fuel at the older Oneida-street station of the same company it was considered that a plant designed and built specially for burning pulverised coal would operate with higher efficiency than a plant burning ordinary coal in furnaces fed by mechanical stokers.

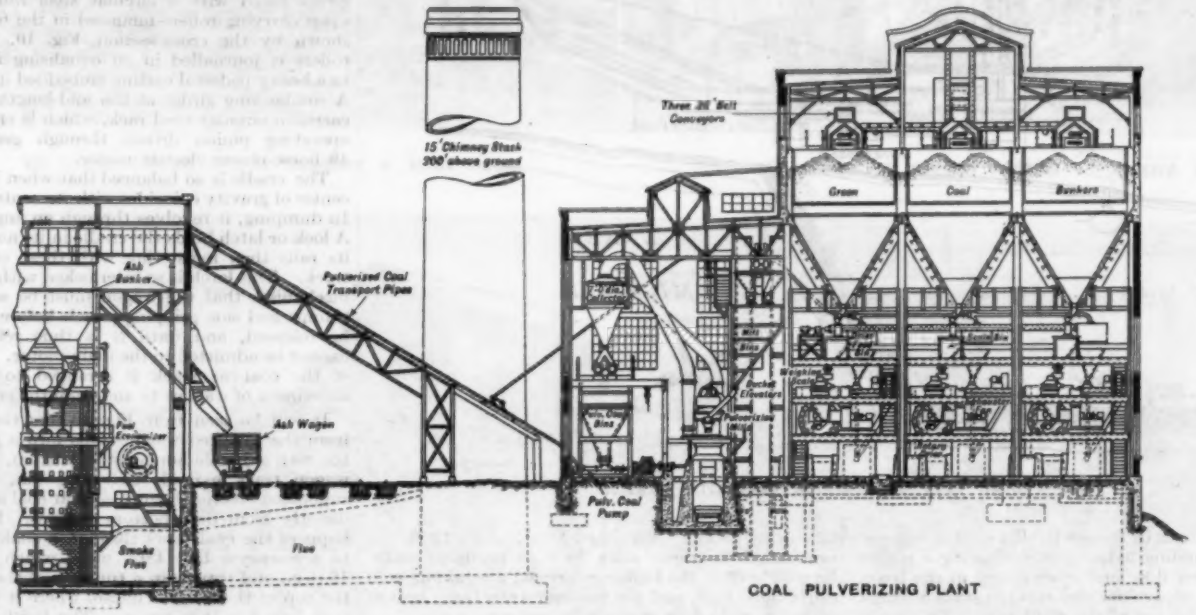
The first section of the station, with a capacity of 40,000 kilowatts, is now in service, and comprises eight boilers with 13,600 square feet of heating surface, and two 20,000-kilowatt turbo-generators. There is also a 30,000-kilowatt turbo-generator, but this is for reserve, and is supplied by the same boilers. Other features include a coal storage yard, coal-handling and pulverising plant, and condenser intake and discharge tunnels of sufficient capacity for the ultimate size of the plant.

This great generating station will serve the company's extensive local and suburban tramway system and its inter-urban electric railways, as well as a large part of the lighting system of the city. It was designed by the company's staff and built under its direction, largely by the company's own forces. The principal officers in charge of the design and construction were Mr. R. H. Pinkley, chief engineer of ways and works; Mr. John Anderson, chief engineer of power plants; and Mr. G. G. Post, chief electrical engineer. A general plan of the present plant and its future development is given in Fig. 2.

As long ago as 1915 the rapidly increasing demand for electrical energy in and around the city of Milwaukee led the company to consider plans for increased generating capacity. A study of the conditions indicated that ultimate economy would be served by constructing an entirely new plant which would not only provide the necessary increase in capacity but would eventually relieve the existing stations of the larger proportion of their load. Owing to difficulties with adequate water supply and the handling of coal and ashes at the installations within the city it was decided to erect the new station on the shore of Lake Michigan and about a mile south of the city. At that time it was intended to use coal from eastern mines and to have all of it brought in by steamers, so that the plans included a small harbour with coal piers and storage yards served by travelling gantries or bridges for unloading, stocking and reclaiming the coal. At that stage the entry of the United States into the World War made it necessary to postpone all work on the new plant and to concentrate efforts toward getting the utmost capacity out of the existing stations and equipment.

By the end of 1919 the increased load impelled the company to take up the project again, and orders were given to proceed with the plans and to build the first section of the station with its two 20,000-kilowatt turbo-generators. This was done in spite of the unfavourable conditions of high prices and wages and low labour efficiency. Under orders from the Government Fuel Administration—then in control of the coal supply and distribution—it was necessary to use coal from the mines of Illinois instead of from those of eastern States. This necessitated an entire change in the arrangement of the buildings and equipment, as well as a postponement of the harbour work and piers to some time in the future. This change in plans was influenced also by the highly successful results of experiments in the use of pulverised coal at the company's Oneida-street station, which, and the experiments carried out in it, have already been described in THE ENGINEER. On the basis of these results it was decided to equip the new plant for the use of pulverised coal exclusively.

The changed conditions made it necessary to re-design the station and prepare an entirely new set of plans in a very short period of time. The whole work of engineering design and of getting out the plans was done by the company's staff, and a large part of the construction and installation work was carried out by the permanent employees. All other work was executed under the direction of the company's engineers, the company acting in the capacity of general contractor and letting sub-contracts for various items of the work. This was in accord with the general policy of the company, which recognises that it has in its employ engineering talent fully competent to handle such projects and more familiar with the company's work and conditions than any outside engineers. At the outset of the work, Mr. S. B. Way, the general manager, appointed a committee of officers to co-ordinate the various branches of the undertaking. This committee, which held weekly meetings, was composed of the chief engineer of power plants—as chairman—the purchasing agent, general auditor, engineer of way and works, electrical



COAL PULVERIZING PLANT

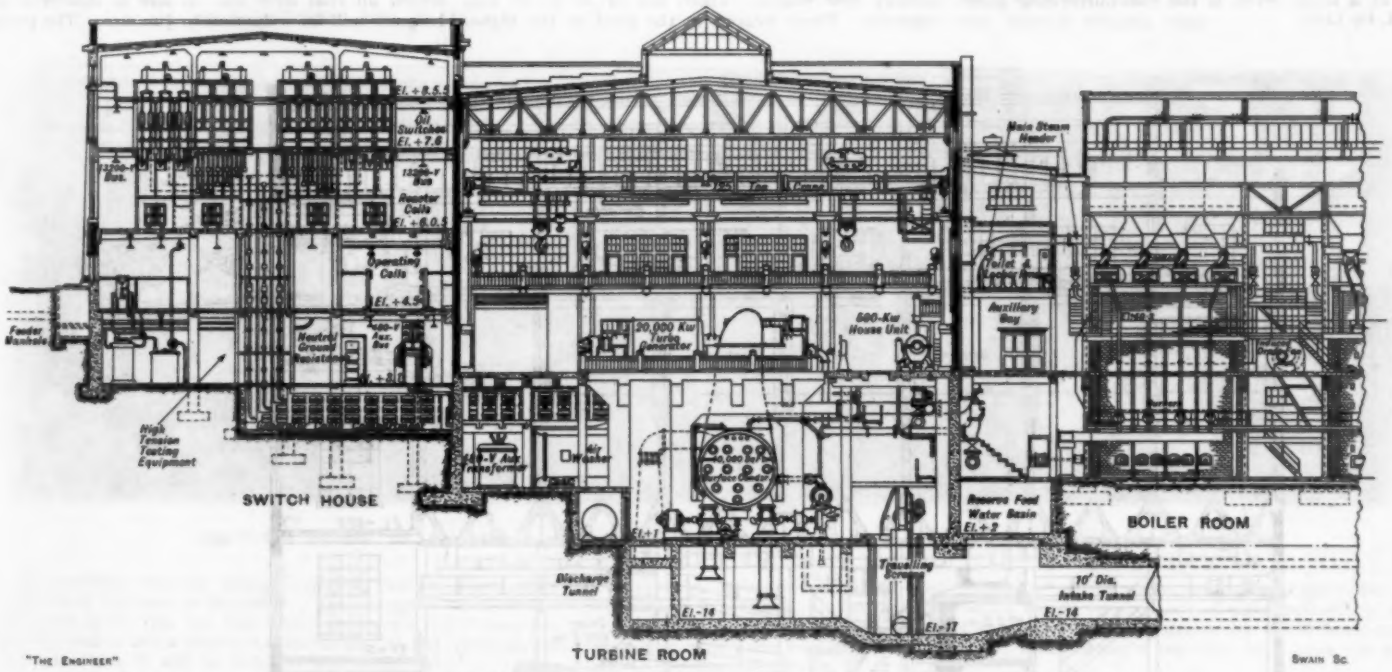


FIG. 1—PART LONGITUDINAL SECTIONS THROUGH MAIN BUILDINGS OF LAKESIDE POWER HOUSE

engineer, switchboard engineer, and the chief designer of the power department.

The arrangement of the principal parts of the plant is illustrated by the plan—Fig. 2—and the longitudinal section—Fig. 1. The main building—about 375ft. by 110ft.—has its length divided into a boiler-room, 210ft.; turbine room, 90ft.; and switch room, 75ft. The south wall of the turbine room is temporary and will be removed when new units are

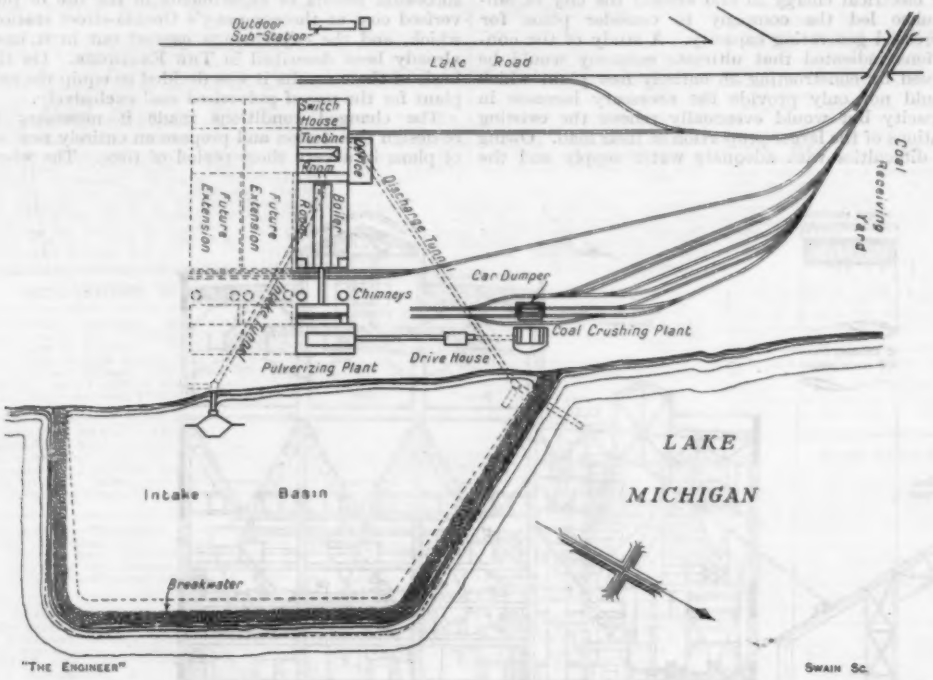


FIG. 2—GROUND PLAN OF LAKESIDE GENERATING STATION

installed. Adjacent to the north side of this room is a two-storey building 95ft. by 52ft., having a repair shop on the lower floor and store rooms in the basement, while the upper floor contains the station offices and a hall for the use of the employees. This main building is about 50ft. above the water, and beyond it are two concrete chimneys. Beyond these again, and at a lower level, is the coal-pulverising plant, 108ft. by 125ft.

the station site, which is provided with 5 miles of sidings, was formed. The branch line and yards are equipped with overhead wires for operation by electric locomotives.

Coal Crushing and Pulverising.

The coal receiving and crushing house is about 400ft. from the main building, and its situation on the sloping bank above the shore presented construction difficulties. The building—108ft. by 125ft.—is surrounded on three sides by high retaining walls, the west wall of the building forming a retaining wall nearly 50ft. high, and the two end walls being braced to the concrete floor systems by concrete struts.

An unusual feature in power station equipment is the use of a car-dumping machine to unload the railway coal wagons, which are of 30 to 50 tons capacity. These wagons in the yard at the higher level are delivered singly to a revolving cylindrical cradle in which they are secured. The cylinder then revolves on its horizontal axis, tipping the wagon so as to discharge its contents into a pit or hopper built into the ground alongside the cradle. In Fig. 4 the cradle is shown after having made a half revolution so that the track rails on which the wagon stands are in a vertical plane. Other positions are illustrated in the group of engravings, Figs. 5 to 9.

Thus, in Fig. 4, the cradle is in normal position ready for the reception of a railway wagon. Fig. 6 shows the side on which the electric motors and operating mechanism are mounted. In Fig. 7 the cradle is rolling over towards the left, and Fig. 8 is another view of the machine in operation, while in Fig. 9 the wagon is shown in a practically inverted position.

This wagon-dumping machine—of the Robbins-Scherzer type, and built by the Robbins Conveying Belt Company, of New York—has its cylindrical steel cradle 50ft. long, and large enough to receive 40ft. open wagons up to 10ft. in width and 11ft. in height above the rails, with capacities up to 90 tons of coal. When the wagon is in position, hooked clamps engage the top of the body, and the sliding panels on the rear side are forced inward to grip the side and underframe between the panels and the opposite side of the cradle. At each end is a ring girder faced with a circular steel rail, which rides upon carrying rollers mounted in the foundation—as shown by the cross-section, Fig. 10. Each pair of rollers is journalled in an equalising frame pivoted to a heavy pedestal casting embedded in the concrete. A similar ring girder at the mid-length of the cradle carries a circular steel rack, which is engaged by the operating pinion driven through gearing from a 40 horse-power electric motor.

The cradle is so balanced that when it is empty its centre of gravity coincides with its centre of rotation. In dumping, it revolves through an angle of 150 deg. A lock or latch holds the cradle in its normal position, its rails then registering with these of the coal-car track. This latch is so interlocked with the operating mechanism that the wagon must be secured by the clamps and side gripping panels before the latch can be released, and until it is thus released current cannot be admitted to the main motor. The gradient of the coal-car track is arranged to facilitate the movement of wagons to and from the cradle.

It will be seen from Fig. 10 that the coal flowing from the inverted wagons falls into a great concrete bin with a double-hopper steel bottom. Another coal wagon track extends over this bin, with its rails supported on cross beams, so that coal can be dumped directly from drop-bottom wagons. From the two hoppers the coal flows through a shaking-bar screen to a conveyor belt 48in. wide, which is inclined at 18 deg., and travels in a tunnel and then a gallery to the top of the crusher house, where it discharges the coal into a rotary screen. The head pulley of this conveyor is highly magnetised in order to remove scrap iron from the coal. From the perforated screen all coal over 2in. in size is delivered to a hammer mill for reduction to ½in. size. The product

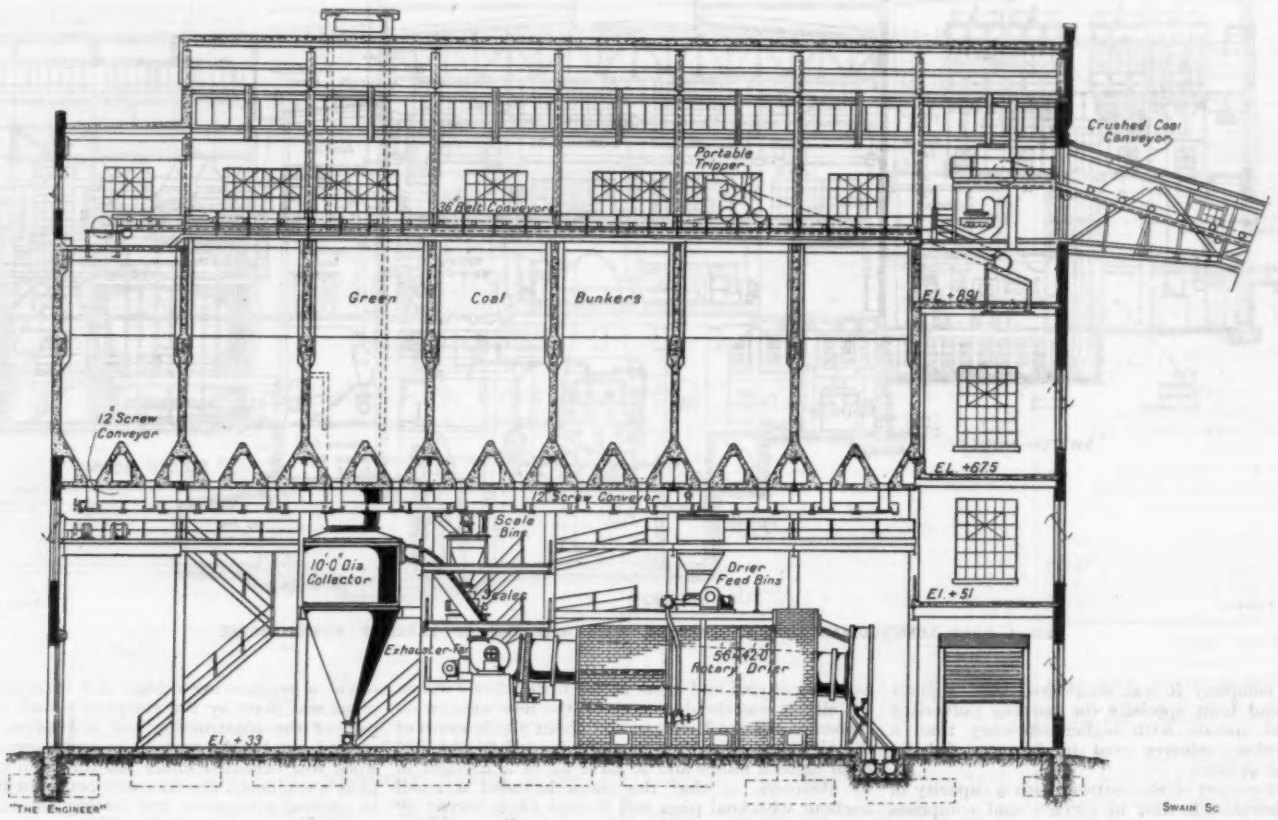


FIG. 3—SECTION THROUGH COAL DRYING AND PULVERISING BUILDING

The first steps taken were the building of a short double-line branch railway and the laying of a water supply pipe line. Near the junction with the main line of the Chicago and North-Western Railway—about a mile distant—was built a coal yard having six lines of rails served by a locomotive crane and with space sufficient for storing 100,000 tons of coal. At the same time the coal storage yard on the north side of

from this mill is fed to a 36in. belt conveyor for delivery to the pulverising plant.

The coal-crushing and screening plant will handle 150 tons per hour, but if the coal delivered by rail is sufficiently fine that it can be discharged directly to the 36in. belt, the capacity will be about 250 tons per hour. This is the carrying capacity of the belt at a speed of 250ft. per minute. Provision has been

ROBBINS-SCHERZER CAR-DUMPING MACHINE AT LAKESIDE POWER HOUSE

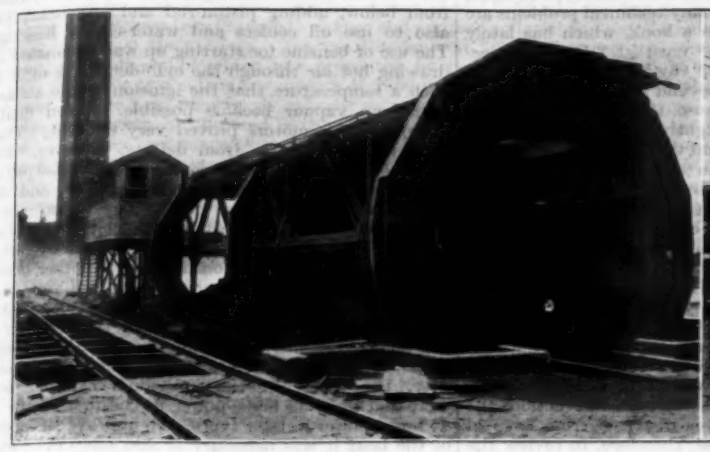


FIG. 4—THE CRADLE TURNED THROUGH A EIGHT ANGLE

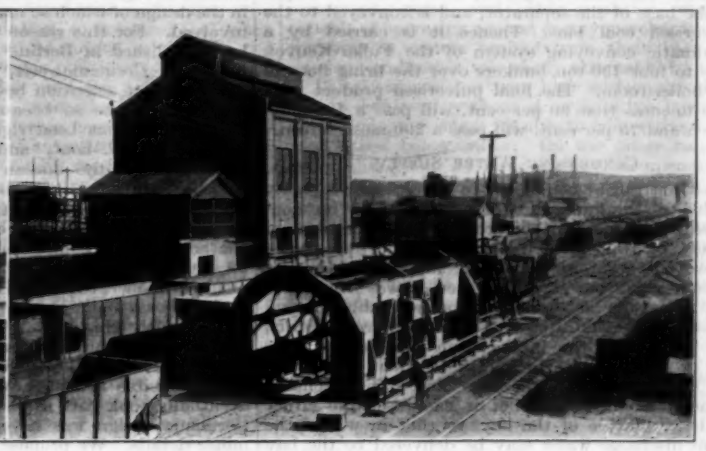


FIG. 5—THE CRADLE IN NORMAL POSITION TO RECEIVE WAGON

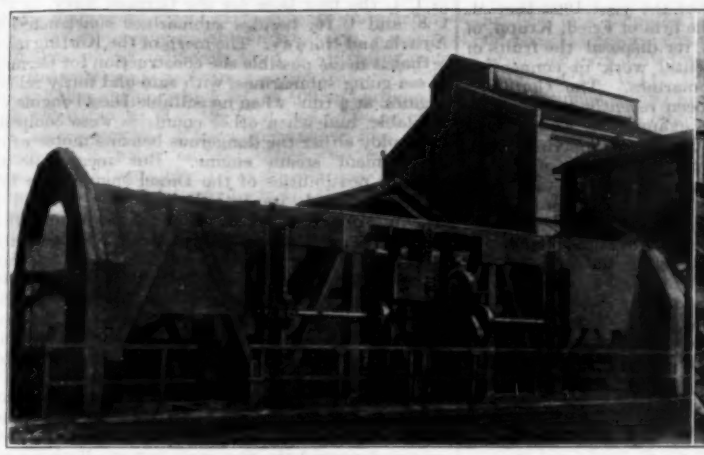


FIG. 6—MACHINERY SIDE OF CRADLE

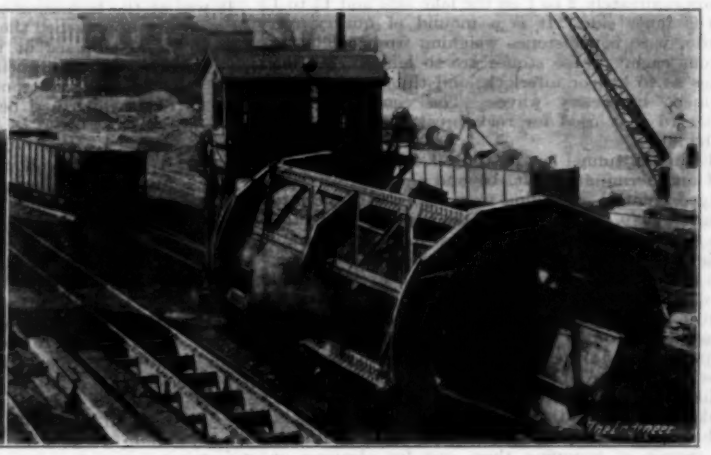


FIG. 7—THE CRADLE ROLLING OVER

FIG. 8—THE CRADLE ROLLING OVER

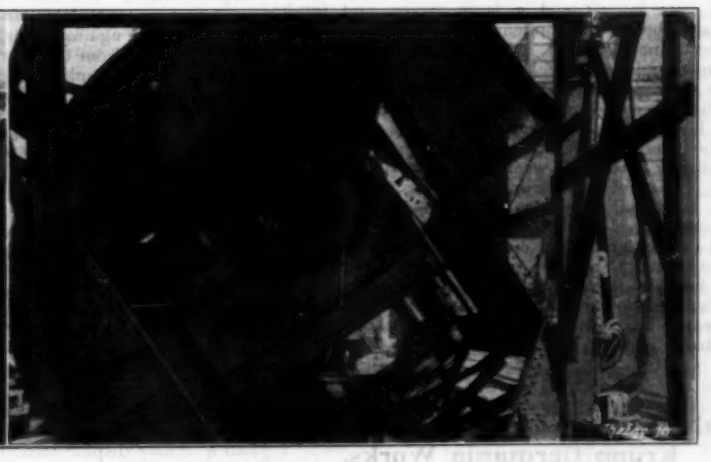


FIG. 9—CRADLE WITH COAL WAGON INVERTED

made for another crushing unit in order to double the capacity of this part of the plant. For storage of coal brought in by rail, the first 48in. conveyor will deliver the coal to other conveyors discharging at the stock yard, where it will be handled and reclaimed by a travelling bridge or gantry with traversing trolley and grab bucket.

To return now to the pulverising plant, which is shown in cross and longitudinal section in Figs. 1 and 3. The crushed coal from the crusher house is brought to this building by the 36in. belt conveyor. This conveyor rises 91ft. in its length of 385ft., and delivers the coal to a series of conveyors, which distribute it over the storage bin. This bin has a capacity of 3400 tons, or sufficient for 3½ days' supply to the boilers. Three screw conveyors take the coal from the bunker and pass it to automatic weighing scales, from which it is passed to the dryers by another set of screw conveyors. With this arrangement coal can be taken from any part of the bunker and delivered to any one of the three dryers. It also permits of weighing the coal just before it reaches the dryers, which is considered decidedly preferable to measuring coal as it enters the bunker, since it enables a close check to be kept on the daily consumption in the plant. There are three rotary dryers of 5½ft. diameter and 40ft. length. They are heated by the gases from furnaces burning pulverised coal. Each dryer can reduce the moisture content of the coal from 10 per cent. to 2 per cent. at the rate of 10 tons per hour. The gas from the dryers is passed through collectors which receive the coal dust.

Another set of screw conveyors carries the dry coal to the 25-ton hoppers of eight pulverising mills of the ball type, each driven by a 100 horse-power motor, and having a capacity of 6 tons per hour.

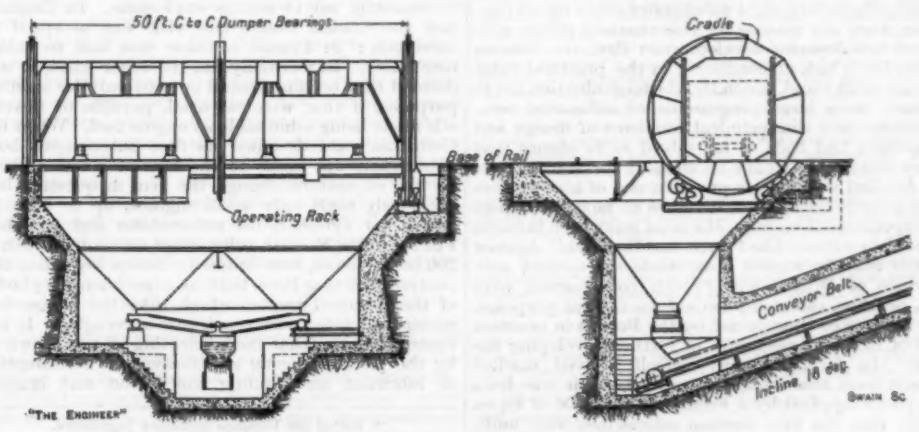


FIG. 10—COAL DUMPING AND CONVEYING ARRANGEMENTS

Each mill has a fan and cyclone separator, by which only particles of the required fineness are drawn off by the air current, so that no screens are required. This fine dust falls by gravity into a screw conveyor at the base of the separator, and is conveyed to the pulverised coal bins. Thence it is carried by a pneumatic conveying system of the Fuller-Kenyon type to four 150-ton bunkers over the firing floor of the boiler-room. The final pulverised product is of such fineness that 90 per cent. will pass a 100-mesh screen and 75 per cent. will pass a 200-mesh screen.

Condensing Water Supply.

With the plant completed to its ultimate capacity of 200,000 kilowatts, it will require water for condensing purposes at the rate of 360,000 gallons per minute, or 518,400,000 gallons per twenty-four hours. In order to secure this enormous supply from the lake without going out to deep water, it was decided to form an intake bay by building a rock rubble-mound enclosure or breakwater to exclude sand, ice and drift, and to protect the intake from the waves. This bay or pond—shown in Fig. 2—is about 850ft. long and 500ft. wide from the shore line. The discharge tunnel is so arranged that it can discharge either inside or outside of the bay, so that in winter the warm discharge water may be delivered to the bay to prevent it from freezing over.

The breakwater is in 16ft. of water, with its top 10ft. wide and 8ft. above the water level. Its slopes are approximately 2 to 1 on the lake side and 1½ to 1 on the inner side. It is a mound of quarry run granite, with cover stones weighing from 500 lb. to 15 tons each. These stones are so laid by floating cranes as to key or interlock, and thus prevent dislodgment by heavy waves. The construction is similar to that used for rock breakwaters at ports on the lakes.

The intake tunnel has its top 5ft. below the water level and terminates 50ft. beyond the shore line, a dredged channel extending from its mouth out into the intake bay. The mouth of the tunnel is protected by a floating timber boom or guard to keep ice away. Behind this is a submerged weir of steel sheet piling, with its top 5ft. below the surface, to exclude sand and dirt, and finally there is a screen of steel bars 6in. apart. Inside the station the circulating water passes through two revolving or travelling screens of ½in. mesh, and then reaches a large suction chamber. These screens were built by the Chain-Belt Company, of Milwaukee. Gate houses are provided at the outer or lake ends of both the intake and discharge tunnels, so that stop logs can be placed to close the tunnels and permit of pumping them out for cleaning or inspection.

The circulating water system required over 1100ft. of tunnel and 150ft. of construction shafts, together with gate houses and a large screen and intake chamber below the condensers in the turbine-room. These tunnels are 10ft. in inside diameter, and have a concrete lining 12in. to 18in. thick. The shafts were sunk near the mid-length of the tunnels, and headings were driven in both directions, thus working four headings with day and night turns.

The tunnels were mainly in stiff wet blue clay which was hard to excavate, but needed full timbering. After some experimental work it was found that tunnelling could be done most expeditiously by compressed-air tools. The pneumatic tampers used in packing ballast on the permanent way were adapted to this purpose by fitting them with blades like hoes or broad chisels instead of the tamping heads. In the discharge tunnel a water-bearing vein of gravel was encountered and caused considerable trouble and de'ay.

Submarine Construction at the Krupp Germania Works.

It is a notable fact that the belligerent State which made most use of the submarine during the Great War should have been almost the last to introduce that type of vessel into its navy. Not until the end of 1904, when other Powers already possessed numerous submarines, did the German Navy order its first boat, and upon the outbreak of war, ten years later, it had only twenty-eight submarines ready for service. There were two reasons for this cautious policy with regard to submarine development: first, the German Admiralty's lack of confidence in the practical value of such craft; and, secondly, its determination not to embark on a large programme of submarine construction until the technical problems of design and propulsion had been so far solved as to ensure that every boat built would be efficient for war service. As Admiral von Tirpitz put it in one of his speeches before the Reichstag: "We have no money to waste on experimental vessels. We must leave such luxuries to wealthier States like France and England." Against this it may be argued that, while the earliest submarines of British and French construction were not, perhaps, of much practical use for war purposes, the experience thus gained by the Powers in question was of material assistance in further developing the type. In fact, Germany herself derived marked benefit from this foreign enterprise, for it was from the plans supplied by a French engineer, M. d'Equevilley, that the first German submarines were built, and the same basic design was adhered to in almost all the boats she constructed from 1904 to 1918. The evolution of the submarine is a matter of peculiar interest to engineers, for there is no other type of vessel in the design of which so many technical problems are involved. For this reason a book, which has lately been published in Berlin,* entitled "Die Untersee-boote der Germaniawerft," by Dr. Techel, will no doubt attract attention beyond the confines of Germany, the more so because the Krupp Germania yard at Kiel has been rightly termed "the cradle of the German U-boat," and the author was for many years chief of the bureau of construction at that famous establishment. After giving a brief historical survey of submarine construction at the Germania yard, Dr. Techel treats at considerable length of the characteristics of submarine design, the development of structural features, propelling machinery, equipment, armament, &c., and then goes on to describe typical boats built at the yard from 1902 to 1918. Consequently this book, which is richly illustrated with diagrams and engravings, represents an authoritative treatise on the evolution of the German type of submersible boat, for while other German yards eventually took part in submarine construction, the Germania design was never departed from save in minor details. We propose, therefore, to review the volume at some length, containing as it does a wealth of data on a subject of special interest to students of technology.

It was at the beginning of the year 1902 that M. d'Equevilley approached the firm of Fried. Krupp, of Essen, offering to place at its disposal the fruits of his research and experimental work in connection with the building of submarines. The Germania yard at Kiel, which had been recently acquired by the firm, was instructed to examine M. Equevilley's project, and, a favourable report having been rendered, the inventor entered the service of Messrs. Krupp. As early as February of the same year work was started on the plans for an experimental boat which the firm had decided to build on its own responsibility, the German naval authorities not being prepared as yet to allot funds for submarine construction. Laid down in July, 1902, the boat was built with great secrecy, though it embodied no radical modification of the then conventional principles of design. The object was simply to provide Messrs. Krupp with a full-size model by means of which the laws of submarine navigation could be studied at first hand and sufficient experience gained to justify the building of larger vessels. The Forelle, as the boat was named, displaced only 16 tons in surface trim, and could therefore be carried on board a large warship, but so far as is known it was never actually transported in this way. The armament consisted of two outboard torpedo tubes. The first trial took place in June, 1903, and a month later the boat carried out a submerged attack against a target moored at a distance of three miles from the starting point. The Forelle was, in fact, a complete success in everything but its speed, which was considerably below the designed figure.

Even before this boat was finished plans had been prepared for a larger type of submarine which would be autonomous—that is, able, when running on the surface, to use its oil engines for charging the accumulators which supplied current to the electromotors for submerged cruising. Even at that early date an attempt was made to eliminate the danger inseparable from the use of benzine as fuel by designing a petroleum motor, the fuel for which was to be carried in tanks outside the pressure hull. This system of storage, patented by d'Equevilley in 1904, was adopted in all the later German submarines of large cruising radius. The first submarines built to order at the Germania yard were three boats for the Russian navy, named the Karp, Karass, and Kambala, the contract for which was received in June, 1904. Each had a surface displacement of 205 tons and was propelled by a petroleum motor of about 400 horse-power.

At a very early stage in submarine construction it became evident that the internal combustion engine was superior to all other forms of motive power for this type of craft. But as no heavy oil marine engine had been perfected at that time it was necessary to adopt benzine or petrol motors, the use of which not infrequently led to serious explosions. In England and the United States this risk was accepted as inevitable; in France recourse was had to steam machinery. In Germany, on the other hand, it was decided that benzine should be used only for starting purposes, if that were essential, paraffin or heavier oils alone being admissible as engine fuel. When the Germania yard designed its first autonomous boat application was made to the firm of Körting Bros. for the oil motors, though the firm in question had previously built only small engines, up to 8 horse-power per cylinder, for automobiles and launches. For the three Russian submarines six motors, each of 200 horse-power, were ordered. Before beginning this contract Körting Bros. built an experimental cylinder of the required power, which, like the automobile motor, was fitted with crank case scavenging. It was found, however, that the lubricating oil was drawn up by the piston, causing an extravagant consumption of lubricant and fouling the piston and ignition apparatus, which soon led to misfires. Moreover, the driving gear became intensely hot and soon wore away. The firm accordingly resolved, when building the Russian submarine engines, to close the cylinder from below, adding piston-rod and crosshead, and also to use oil coolers and water-cooled bearings. The use of benzine for starting up was eliminated by drawing hot air through the cylinder, bringing it to such a temperature that the ignition of the air and petroleum vapour became possible. When finally completed the motors proved very efficient. They were not wholly free from defects, however. For example, after considerable service the uncooled piston developed cracks and had to be replaced, and the contact-breaking ignition fittings were too much exposed to wear—troubles that were met by replacing the pistons after a given length of time and by carrying on board spare ignition fittings. Another drawback, especially from the military point of view, was the vapour from the exhaust pipe, which, being visible at a great distance, tended to betray the presence of the boat. The heavy consumption of fuel was also a serious matter. In spite of these difficulties, however, the power of the individual cylinder was increased from 33 horse-power in the first motor to 45 horse-power in later types. To improve the speed of the boat it was necessary to add more cylinders, as many as sixteen, comprising two motors, working one shaft in some cases.

Motors of the type described above were also fitted in U 1, the first boat for the German Navy, in U 5, U 8, and U 16, besides submarines constructed for Austria and Norway. The merit of the Körting motor is that it made possible the construction for Germany of sea-going submarines, with safe and fairly reliable engines, at a time when no suitable Diesel engine was available, and when other countries were compelled to employ either the dangerous benzine motor or the inconvenient steam engine. But meanwhile the superior possibilities of the Diesel engine were fully realised, though its introduction was delayed on account of the restrictions which the naval authorities imposed on weight and dimensions. The first Diesel submarine engine was built at the Germania shops in 1906–07. It was a four-cycle four-cylinder motor, developing 300 brake horse-power at 450 revolutions, and with cranks so arranged as to permit two-cycle starting and reversing. As at this time the question as to whether the four-cycle or the two-cycle system was preferable for marine engines had still to be settled, the Germania firm also built an experimental cylinder of about 50 horse-power at 500 revolutions for a single-acting two-cycle motor. German naval opinion favoured the two-cycle system, both because of its lighter construction and the absence of the exhaust valve, which in four-cycle engines frequently gave trouble during a prolonged run. The increased consumption of fuel was disregarded as a minor point. In November, 1908, the Navy Department ordered a two-cycle submarine motor of 850 horse-power, but difficulties in the preparation of drawings, patterns, castings, &c., so hampered the work that the motor was not ready for its trials until May, 1911. These being successful, seven similar motors were at once ordered, and, together with the first one, constituted the surface propelling machinery of submarines Nos. 23 to 26. Each motor comprises two groups of three working cylinders, with two scavenging pumps at the forward and rear end, and a double crank four-stage compressor in the centre. This system of division was adopted in order that each group should be capable of independent working. The control platform and the cam shaft drive are situated in the centre. The scavenging pumps have slide valve gear. Reversing is effected by moving a cam shaft fitted with cams for going ahead and astern. In each cylinder cover there are three scavenging valves, a fuel valve, a starting valve, and a safety valve. The bed-plate, crank case, cylinder, cylinder cover, cylinder for scavenging pump and the compressor are all made of bronze, to save weight, avoid casting troubles, and prevent corrosion from water cooling. The crank shaft is of nickel-chrome steel. Twenty-two further motors were shortly afterwards ordered for submarines Nos. 31 to 41. As compared with the preceding engines, they had the same stroke of 15.78in., but the bore of the cylinder was 3.9in. larger and the engine was designed to give 925 horse-power at 430 revolutions.

Before this contract was completed orders were placed by the Austrian and Russian Governments for submarine motors of 1150 and 1200 horse-power. They differed from previous types in the arrangement of the scavenging and air pumps, having only one scavenging pump—two cylinders one above the other—and a three-stage air supply pump, placed at the forward end. In this way the number of cranks was reduced to two, the length of the engine curtailed, and the operation of the water and oil pumps improved. Delivery of the Russian engines was prevented by the outbreak of war, and they were accordingly installed in the German submarines U 63 to 65. They proved very reliable in service, the engines of one boat running at sea for 160 days without repair or thorough overhaul. Owing to the scarcity of copper and tin during the war, the use of bronze had to be cut down to a minimum. The Germania works therefore decided to employ cast steel for bed-plates, crank cases, and cylinders, and cast iron for scavenging pump and compressor

* Verlag des Vereines deutscher Ingenieure.

cylinders. This made certain structural modifications necessary. The crank pits (Kurbelwannen) were built of welded ingot iron plates. The usual form of double-walled bronze cylinder with cast iron liner was superseded by a single-walled cylinder of cast steel, having a thick cast iron liner, with rubber and copper packing against the exhaust. Another Russian contract, the delivery of which was prevented by the war, called for two submarine motors of 1650 horse-power. These were likewise six-cylinder engines with valve scavenging, but differed in the arrangement of the air supply and scavenging pumps. At the forward end were three cranks, two of which served to drive the scavenging pump piston and the low-pressure and intermediate-pressure pistons of the air supply pump, while the high-pressure piston was worked by the middle crank. These engines were later fitted into the U 139, the first "submersible cruiser" to be completed.

As the Germania works alone could not cope with the great demand for submarine engines which resulted from the war, the German naval authorities contracted with the M.A.N. firm for four-cycle motors of 1200 horse-power, and with the Daimler Company for engines to drive the smaller boats specially built for service in Flanders. Körting engines were also fitted in boats built at the Germania yard. In addition to the two-cycle types described above, the Germania shops constructed a considerable number of four-cycle motors, the first of which was installed in the commercial submarines Deutschland and Bremen. As the main requirement in these boats was machinery that was simple and reliable in operation, a motor of 450 horse-power, originally built as a lighting engine for the battleship Sachsen, was requisitioned. This six-cylinder engine, which ran at 400 revolutions, was not reversible, so that the boat had to go astern on her electromotors, a form of manœuvring largely employed in other navies. After two commercial voyages the Deutschland was reconstructed as a war cruiser, under the designation of U 155. The Bremen disappeared on her maiden voyage. In 1916 the firm was requested to supply four 1700 horse-power engines for large submarines, and as meanwhile the four-cycle type had proved well suited to war service requirements, they were constructed on that system.

General Machinery and Armament.

Following this review of oil engine progress, Dr. Techel proceeds to trace the development of machinery for submerged cruising, *i.e.*, electric motors and accumulators; auxiliary machinery, and other equipment connected with the propulsion of submarines. He then describes various improvements in periscopes, navigational instruments, submarine signalling, wireless telegraphy, armament, berthing accommodation, and safety devices. The section on periscopes is particularly interesting in view of the admitted superiority of the German instruments in the early part of the war. Descriptions and diagrams are given of each successive type of periscope, from the somewhat primitive form in the Forelle, of 1903, to the highly efficient instruments fitted to the U-cruisers of 1918. Students of wireless telegraphy will also find much to interest them in the narrative of progress made in the application of this system of communication to submarine boats. The first German boats to be so equipped were the U 5 and U 8, in which the apparatus was placed in the motor compartment without any cover. A special wireless telegraph cabin was first provided in the "U 23–26" class. Within ten years the day range of submarine wireless telegraphy had increased from 200 miles to many thousands of miles.

Turning to armament, Dr. Techel asserts that the true weapon of submarine warfare, save in special cases, always has been and will continue to be the torpedo, notwithstanding the adaptation of these boats as gun carriers and minelayers. When the first really effective submarine came into service—that is to say, in 1900 or thereabouts—the torpedo had already reached a fairly high state of efficiency. The type then in general use had a diameter of 17.72in., a length of 16.4ft., a range of 3280ft. at a speed of 35 knots, and of 6560ft. at 25 knots. The gyroscopic gear made the weapon very accurate, especially at short range. The war head consisted of 198 lb. to 220 lb. of wet compressed guncotton. Torpedoes of this type were supplied to all German submarines up to and including U 18. But with the adoption by other Governments of the 21in. torpedo, a new model of 19.69in. diameter was produced for the German Navy and furnished to all submarines after U 18. Thanks to the enlarged diameter, the range, speed, and weight of war head were all increased, the speed being further accelerated by the fitting of a heater device. Not content with merely adding to the weight of the war head, the German authorities increased its destructive power by substituting a more potent explosive for guncotton—presumably T.N.T. The arrangement of torpedo tubes, compensating tanks, and torpedo hatches in early and later Germania boats is fully described and illustrated. The great size and weight of the modern torpedo and the large number which an ocean-going submarine has to carry have added materially to the difficulty of designing and constructing these vessels. Mines and mine-laying gear are also discussed, and the various systems of storage and expulsion adopted in German boats are explained.

At the outbreak of war very few submarines were armed with guns. The German boats had machine guns, and one or two British submarines carried a small-calibre quick-firer. In the German Navy the U 35 was the first to be fitted with a 3in. gun, on a collapsible "dry" mounting, so arranged that when not in use the gun could be housed below deck and quickly brought up to firing position by spring rams. This mounting was also used for 3.4in. 30-calibre guns. As the German submarines were employed more and more for commerce destruction, it became necessary to arm them with guns sufficiently powerful to sink merchant vessels with one or two shots. To provide "dry" mountings for these would have been difficult, if not impossible. They were therefore permanently mounted on the deck, fully exposed, of course, to the water when the boat dived; but the effects of such immersion were largely nullified by the lavish use of paint and grease on the gun and its mountings, the fitting of water-tight tompions and breech packing to preserve the lands of the rifling from corrosion, and the removal into the interior of the boat of sights and other sensitive fitments when the gun was not in use. It was found that guns so mounted remained perfectly serviceable after being many months at sea. From 3.4in. the calibre of U-boat ordnance speedily advanced to 4.1in., a 45-calibre high-velocity model of this gun being mounted in later boats. With the advent of the submersible cruiser the 6in. 45-calibre quick-firer was adopted, this being by far the most powerful piece of artillery ever mounted in an underwater craft. Some of the U-cruisers completed at the date of the Armistice were armed with no less than three of these guns, but the U 142, the last cruiser to be actually commissioned during hostilities, had two 6in., as also had the converted mercantile boats of the "Deutschland" class. As the ammunition for these guns was heavy—the projectile alone weighing 101 lb.—and a considerable number of rounds had to be carried on board, the problem of ammunition storage and of compensating for the weight lost by its expenditure was one of some difficulty. As regards the latter, it was overcome by so subdividing the magazine as to enable it to be used itself as a compensating tank, water being admitted to every compartment from which the shell or cartridge had been taken. Hand-worked hoists were provided for the 6in. ammunition in early cruisers, and power hoists in the later boats. To ensure the most accurate practice with these powerful guns long-base range finders were installed on deck in the larger U-cruisers. In fact, their gunnery equipment was almost as elaborate as it would have been in the case of a surface man-of-war.

Progress During the War.

At the beginning of the war the Germania yard had twelve submarines in varying degrees of construction. When mobilisation was proclaimed additional boats were at once contracted for by the naval authorities, and in order to minimise delay it was proposed to model them on the latest successful type then in hand, viz., the U 41, a boat of 684 tons. But as war experience soon indicated the desirability of certain departures from previous practice, the war-built boats differed in several respects from earlier types, and these differences became more marked as the campaign progressed. A few of the leading modifications may be briefly noted. It was found that the time usually occupied in flooding tanks for diving—viz., about five minutes—was far too long, rapid submergence being of paramount importance in war operations. This necessitated larger flooding valves and a more powerful system of air expulsion. A demand was also raised for a stronger torpedo and gun armament, while the cruising endurance of the boats was increased by utilising some of the diving tanks as reserve bunkers for oil fuel. Although the power of the surface machinery was augmented, that of the electrical plant for submerged cruising remained practically constant, even in boats of larger dimensions, with the result that underwater speed declined from 10.1 knots to 8.5 knots. It is stated, however, that this circumstance in no way prejudiced the military effectiveness of the boats. The lines of the hull were modified to give better sea-keeping qualities; the upper deck was kept at full breadth almost from end to end; the straight cutwater gave place to a clipper bow; the conning tower was raised and a permanent weather screen fitted to the bridge. Consequently, a U-boat of 1918 differed greatly in appearance from one of 1914, though internally both were very similar. Several special types were evolved during the war, notably the "UB" class, a small torpedo vessel designed to operate from the bases in Flanders; and the small UC minelayers, which were eventually enlarged and fitted with torpedo tubes and gun armament. At the Germania yard, too, were built the commercial submarines referred to above, and the same establishment undertook the reconstruction of these boats when their original purpose had been frustrated by the entry of America into the war.

Submarine Cruisers.

Of the first submersible cruisers proper, viz., U 139 and 141—see Supplement—and U 142–144, the details set out in the table in the next column are given.

While the conversion of the "Deutschland" class into so-called "U-cruisers" was only an emergency measure, undertaken for the purpose of making them available for war purposes, the "U 139–144" class were designed from the beginning as cruisers—that is, as boats which, by virtue of their dimensions, radius, armament, speed, and other qualities, would be capable of operating against enemy merchantmen and warships in waters remote from their base. The requisite endurance was easily attainable by the use of Diesel engines, but very high surface speed could not be achieved without a prohibitive increase in dimensions, nor was it feasible to endow them with a good speed below water. On the other hand, the range and power of their artillery compensated to some extent for lack of above-water velocity, while the low speed when submerged was of minor importance in view of the fact that the gun, not the torpedo, was the principal weapon of offence in this type. It was found possible to give these cruisers a limited amount of armour defence. The conning tower had a protective screen of 2.36in. armour, placed far enough from the tower to ensure that damage to the screen would not affect that structure. The pressure hull was built of stouter plates than were necessitated by the diving depth, and the plates were made of specially strong material. Furthermore, the hatches leading to the interior were fitted with double crowns, and above the torpedo tubes and steering gear there was protective deck plating. So defended, they were less exposed to fatal injury by gunfire than the ordinary type of submarine. The torpedo armament consisted of four bow and two stern tubes. The majority of these cruisers were fitted with two sets of M.A.N. 1750 horse-power four-cycle motors; but one of them had two sets of Germania 1650 horse-power two-cycle engines. All the engines had six working cylinders. For the later U-cruisers two ten-cylinder engines, each developing 3000 horse-power, were built. Only one charging engine was provided, and this could also be used for low-speed cruising in an emergency. As the space did not permit of storing enough drinking water for a voyage of several months' duration, a distilling apparatus was fitted, heated by the gases from the exhaust. The only cruisers that saw any war service were U 139 and U 140, and then for a short period only. Both, it is claimed, proved thoroughly efficient in technical and military qualities. Of the other cruisers, U 141 was commissioned just before the Armistice; U 142, the first boat with the heavier engines, had completed its trials; and U 143 and U 144 had been launched. Four pressure hulls of unfinished submersible cruisers were afterwards utilised in the construction of the oil tankers Ostpreussen and Oberschlesien, built for the Stinnes firm.

Particulars of U 139, 141, 142, 143, and 144.

	U 139 and 141.	U 142–144.
Length overall, feet	301ft. 10in.	319ft. 10in.
Maximum breadth, feet	29ft. 6in.	29ft. 7in.
Diameter of pressure hull, feet	18ft. 9in.	18ft. 9in.
Displacement on surface, cubic metres	1930	2138
Displacement submerged, cubic metres	2484	2800
Engine power on surface, horse-power	2 × 1750	2 × 3000
Speed on surface, knots (estimated)	15.8	17.75
Maximum oil storage, cubic metres	464	557
Radius at 10 knots, in knots	20,000	18,000
Engine power submerged, horse-power	2 × 900	2 × 1300
Speed submerged, in knots	7.6	8.25
Diving depth, in feet	246	246
Number of torpedo tubes	6	6
Number of torpedoes carried	19 of 19.7in.	19 of 19.7in.

Finally, Dr. Techel reviews the output of submarines by the Germania yard from 1902 down to the Armistice. Within this period it delivered 101 boats with a total displacement of *circa* 76,500 tons, propelled by engines of 150,000 horse-power in the aggregate. A further 35 boats of 52,000 tons and 124,300 horse-power were fitting out or building, and 47 more, totalling 47,000 tons, were on order. A very brief reference to the war exploits of Germania-built submarines brings to a conclusion one of the most informative and interesting technical volumes which has been published in Germany since the peace.

Association of Engineers-in-Charge.—The twenty-third annual dinner of the Association of Engineers-in-Charge was held on the evening of Saturday, April 7th, at the Holborn Restaurant. Dr. Hele-Shaw, the President of the Association, took the chair, while Mr. Wm. McLaren was vice-chairman. After the usual loyal toasts had been honoured, Captain Riall Sankey proposed "Research and Practice." In the course of his remarks, he suggested that research would help greatly towards the reduction of costs of production, and said that the research which Dr. Rosenhain had carried out on the alloys of aluminium had indicated the desirability of a special line of investigation on steel. A research into the subject was to be carried out under the guidance of the Royal Society. In his response, Mr. F. Gill explained the great advances which had been made in telephony during the past twenty-one years. Research had, he said, enabled the range of speech to be increased from 400 up to 10,000 miles, while the amount of copper required for the conductor had been reduced from 1600 lb. per mile down to only 80 lb. per mile. The toast of the Association was proposed by Eng. Vice-Admiral Sir George G. Goodwin, who pleaded for less formality in the form of the papers presented before technical societies. The Institution of Marine Engineers had, he said, recently decided to encourage the relation of experiences at its meetings, rather than the reading of papers. Dr. Hele-Shaw responded, and said that the Association was on the verge of being incorporated. The toast of "Our Guests and Friends" was proposed by Captain H. J. Wellingham, and responded to by Mr. H. Baines; while that of "Our President" was proposed by Mr. Wm. McLaren, supported by Captain A. E. Penn, the hon. secretary.

KEYS AND KEYWAYS.

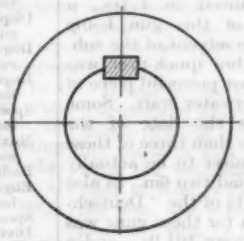
THE Sub-committee of the British Engineering Standards Association, which is engaged in revising the standard specification No. 46 (Keys and Keyways) and enlarging it to cover other forms of keys, has found itself face to face with the fact that the key and keyway nomenclature appears to vary in different parts of the country. Consequently, it has been studying this question with the object of bringing about uniformity, so that, in dealing with different forms of keys and with their dimensions, the names given to keys and their parts should be well understood. It has invited us to publish the accompanying suggested nomenclature, and to invite comments or criticisms in the columns of THE ENGINEER for the assistance of the Sub-committee.

As illustrations of the confusion that exists, the Committee cites the case of the well-known sunk key, which is in some parts called a "feather," and of the recess formed in the shaft to receive the key, which is commonly called a keyway, but sometimes called a "key-seat." Sometimes the expression "keyway" is used for the recess in the shaft, while the recess in the hub or boss is occasionally distinguished from that in the shaft by calling it a "key-seat." This distinction appears to be due to the introduction of what are commonly known as "key-seating" machines for cutting these recesses in the bosses of pulleys and fly-wheels, while, nevertheless, the term "keyway" is generally used in England to represent the recess which is produced by the key-seating machine. When a number of keys are produced integral with the shaft, as in motor car and machine tool practice, the finished shaft is sometimes called a "castellated" shaft and sometimes a "splined" shaft. These illustrations serve to show the desirability of using standard expressions to define standardised objects.

PROPOSALS FOR KEY AND KEYWAY DEFINITIONS, &c., SUBMITTED BY THE BRITISH ENGINEERING STANDARDS ASSOCIATION FOR COMMENT.

It is recommended that the term "castellated" be in no case applied to shafts.

Key.—A piece inserted in an axial direction between a shaft and a hub to prevent relative rotation.



Length of Key.—The overall dimension of the key, taken parallel with the axis of the shaft.

Width of Key.—The dimension of the key measured tangentially to the shaft.

Thickness of Key.—The dimension of the key measured radially to the shaft. In the case of taper keys, the dimension is that measured at the large end.

Taper of Key.—The taper between the top and bottom surfaces in the direction of the length of the key. Taper is expressed as 1 in 100, &c., or as ⅛in. per foot, &c.

Plain Parallel Key.—A parallel key with square ends.

Round-ended Parallel Key.—A parallel key with round ends.

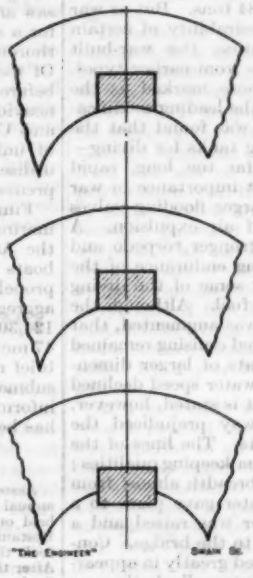
Gib Head Key.—A key provided with a head to facilitate withdrawal.

Plain Taper Key.—A taper key with square ends.

Round-ended Taper Key.—A taper key with round ends.

Square Key.—A key having the thickness equal to the width.

Saddle Key.—A taper key fitted to a pair having a keyway in the hub only, the bottom of the key being curved to fit the shaft.



Flat Key.—A key fitted to a pair having a keyway in the hub and a flat on the shaft.

Sunk Key.—A key partly in the shaft and partly in the hub.

Feather.—A key attached to one member of a pair, and permitting axial relative movement.

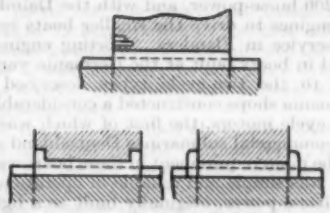
Spline.—A key machined integral with a shaft and adapted to pair with a corresponding recess in the hub.

Spline Shaft.—A shaft having one or more splines. Multi-spline shafts are usually referred to by the number of splines, *e.g.*, "4-spline shaft" or "6-spline shaft," &c., irrespective of the splines being projecting or sunk.

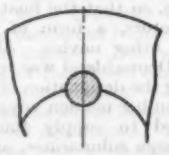
Peg Feather.—A feather with peg to prevent its axial movement in hub.

Single Head Feather.—A feather with a projection at one end to prevent axial movement (of feather) in hub.

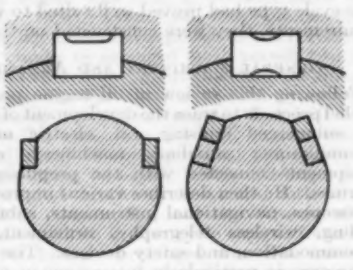
Double Head Feather.—A feather with a projection at each end to prevent axial movement in hub.



Round Key.—A key fitted in a hole drilled partly in the shaft and partly in the hub.

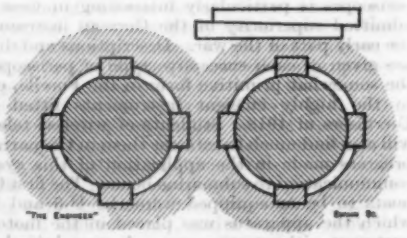


Grooved Key.—A key having a groove, or grooves, lengthwise to facilitate fitting.

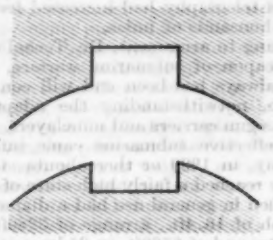


Tangent Keying.—The use of keys acting tangentially in opposite directions.

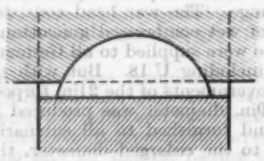
Stake Keying.—The use of taper keys for centralising the hub and for preventing relative movement. They may be fitted as flat keys, or saddle keys may be used.



Keyway.—A recess in a shaft or hub to accommodate a key or feather.



Woodruff Key.—A key segmental in form axially and parallel transversely.



Woodruff Keyway.—A segmental recess in a shaft to accommodate a Woodruff key.

Fitting.—"Top and bottom fitting" when the key bears hard on top and bottom and lightly on sides. "Side fitting" when it bears hard on sides and lightly on top and bottom.

A Seven-Day Journal.

The Helicopter Competition.

IN recommending the Air Vote to the House of Commons on the 14th of last month, the Secretary for Air announced that the research work which had been proceeding in connection with helicopter flying machines was now approaching the stage of full-scale experiment. He was presumably referring to the Brennan helicopter, which has been under construction for some time past at the Royal Aircraft Establishment, Farnborough, and upon which it has been stated the Government has so far expended a sum of nearly £60,000. Simultaneously, he intimated that he proposed to institute a competition in this field for prizes totalling £50,000. It is stated that the conditions of the competition will be announced in a few days' time. Meanwhile, opinion among aeronautical engineers seems to be hardening in favour of the view that the Government would be better advised to devote what money can be spared to the encouragement of research in more orthodox directions, such as in connection with means for making descents on aeroplanes within confined areas in a safe and easy manner. It is urged in support of this view that any advance made in connection with the aeroplane, its propeller or engine would be valuable in the design and construction of helicopters, although such advance would no doubt be primarily applicable to the aeroplane.

British Railways during 1922.

PARTICULARS have been published this week in a summarised statement issued by the Stationery Office concerning the working of British railways in 1922. As compared with the year 1921, the gross receipts showed an increase of £1,600,000, being £237,800,000 as against £236,200,000, while the expenditure at £190,600,000 was £55,600,000 less than in the previous year. The excess of receipts over expenditure was thus £47,200,000, as compared with a deficit of £9,800,000 in 1921. The total net income of the companies from all sources was £54,400,000. The number of passengers carried was, however, smaller, being 1,186,470,000, as compared with 1,217,580,000 in the previous year; while season ticket holders were also less numerous, being 924,000 as against 928,536. Some 301,418,000 tons of goods and minerals and nearly 16,000,000 head of live stock were carried during the year. The average receipts per ton carried showed a considerable diminution, being 7s. 6d. in 1922 and 9s. 10d. in 1921.

Broadcasting Difficulties.

IN the course of a lengthy reply to various criticisms which have been levelled against the British Broadcasting Company and the control which it exercises over wireless telephony reception, the general manager on Monday announced that the company had laid before the Postmaster-General a suggestion to regularise the position of those who desire to construct their own receiving apparatus and who at present escape payment of any fee to the company other than that portion of the licence fee which is handed to it by the Post Office. The proposal was that a new form of licence—a "constructor's licence"—should be instituted, for which a charge of 20s. would be made, of which sum 15s. would be handed over to the company. Meanwhile, the Radio Society of Great Britain, a body with a membership of about 30,000 persons, is seriously disturbed about the effect which broadcasting is having upon scientific wireless experimental work by those interested in the subject professionally or otherwise. It has submitted a lengthy memorandum to the Postmaster-General, in the course of which it suggests that broadcasting stations should be prohibited from issuing high-frequency harmonics or overtones, and should be strictly confined to their proper wave lengths, that the power employed should not be allowed to exceed an allotted figure, and that modern methods of modulation should be made compulsory.

The Legal Standing of the Board of Trade.

THE position of the Board of Trade as a party to litigation formed an interesting feature of an appeal case heard in the Court of Appeal on Tuesday. The case arose out of an action brought against the Board by the Marshal Shipping Company, of Cardiff. The Board appealed against an order of Mr. Justice Rowlatt on the grounds that the plaintiffs had altogether misconceived the legal position, and their legal rights, and that they could not sue the Board of Trade at all, and certainly not by the method they had sought to adopt. The Attorney-General, supporting the appeal, explained that in the times of James I. there existed a body which dealt with trade and foreign plantations, and that in various forms this body continued in existence down to 1872. It was subsequently recognised by Parliament that certain of the duties undertaken by that body had to be carried on, and, accordingly, in 1876 a Committee of about twenty members of the Privy Council was appointed for that purpose. In the Interpretation Act of 1889 it was prescribed that the expression "the Board of Trade" should mean this Committee. In the present case, the writ had been served upon the Permanent Secretary to the Board, and not on a member of the Committee, a fact which, counsel contended, rendered the whole proceeding hopelessly misconceived. Moreover, the company's action was brought against the Board for the recovery of £20,000 paid by the company to the Shipping Controller, whose successor the Board was, it being alleged that the Controller in demanding payment of that sum as a condition of licensing the sale of a vessel belonging to the company to a foreign owner, had exceeded his authority. The Board did not deny having succeeded the Controller, but it was submitted that there was no provision by which such an action as that instituted by the company could be brought. The judgment of the Court of Appeal in this case will be awaited with interest.

A New Auxiliary Glider.

INTEREST in gliders fitted with a small auxiliary engine continues to grow. It is the policy of the Air Ministry to encourage the development of this type of machine, for it is recognised that it affords important advantages as a means of training embryo pilots to fly. An interesting design of auxiliary glider, constructed for the Air Ministry by the English Electric Company, Limited, at Preston, is now undergoing its trials. This machine, known as the "Wren," is a monoplane with cantilever wings and is fitted with a small A.B.C. engine developing 5 or 6 horse-power and driving a tractor screw. It has a designed speed of 48 miles an hour, and a range of 1½ hours, and weighs no more than 205 lb. In comparison with some of the machines entered for the Itford Hill contest last autumn, the new glider shows a considerable improvement in the way of design and workmanship, but it is perhaps noteworthy that it does not follow the winning machine of that contest in having tandem wings. On the first trial of the Wren last Saturday, the machine more than fulfilled expectations, attaining a height of 250ft. and remaining in the air for 7½ min.

Technical Education in the Automobile Industry.

A REPORT, written by those of his Majesty's inspectors who act as advisers on engineering education to the Board of Education, has just been issued by the Board on technical education in the automobile engineering industry. It is admitted that the educational needs of the industry do not differ widely from those of other branches of mechanical engineering in which there is much repetition work. The report emphasises the necessity for educating apprentices in the industry along the broad lines at first of general mechanical engineering, and deplores the "prematurely specialised instruction of a superficial kind" often given in classes having such titles as "motor engineering." Not until the student has completed three years' work in a senior course should, the report says, any degree of specialisation be permitted, although it is justifiable and useful to take examples in drawing and mechanics from the particular form of practical work on which the student is engaged. The report notes a general deficiency of experimental laboratory equipment suitable for students specialising in automobile engineering. Certificates in "motor car engineering" are deprecated, and in their place the ordinary and higher grade national certificates in mechanical engineering issued by the Institution of Mechanical Engineers in conjunction with the Board of Education are recommended.

Accidents in Shipyards.

IN the beginning of March, the Home Secretary, in reply to a question in Parliament dealing with the prevalence of accidents in shipyards, intimated that he was considering the desirability of instituting a special investigation into the means necessary to secure a higher standard of safety. The Boilermakers' Society has since become active in the matter, particularly in connection with the erection of staging. In 1914, the Society states, the Home Office decided that in all cases where it was reasonably practicable staging should be erected by competent men, specially engaged by the employer to do the work, and issued regulations regarding the secure fixing of staging, for the lashing of ladders and so forth. Until recently this order was obeyed by the employers, but, it is alleged, they are now seeking, at certain yards, freedom from it, and asking that the greater part of the safety work should be left to the workmen requiring the staging, no matter whether they are competent or equipped to carry it out or not. The Society has appealed to the Home Secretary, who has now decided to appoint a Committee of Inquiry to deal with the whole subject of safety appliances in shipyards. Meanwhile, the Society is asking the employers to continue their observance of the Home Office Order of 1914 until the committee has issued its report.

The New Battleships.

SPEAKING at the annual meeting of the shareholders of Cammell Laird and Co., Limited, at Sheffield, on Wednesday, Mr. W. L. Hichens, the chairman, dealt with the statement made in Glasgow some three months or so ago by the Prime Minister that they had taken the contract for one of the new battleships at an unprofitable figure. He professed ignorance as to how Mr. Bonar Law had arrived at that conclusion, and said that to the best of his belief they had not made any mistake. After much deliberation they had made up their minds that the contract would be worth having at a certain price, and at that price they succeeded in securing it. Dealing generally with the shipbuilding industry, he remarked that the flicker of activity that had been noticeable a few months back had now died down. At Birkenhead the firm had no fewer than thirteen ships under construction at the present time, but some of them were nearing completion, and he did not pretend that they had anything like as much prospective work as they would like to have in order to guarantee the continuance of the present degree of activity at their yard.

Overtime and Night Work in Shipyards.

FOLLOWING the refusal of the boilermakers' and joiners' unions to take part in, and be bound by the result of, the recent ballot of the members of the Federated Engineering and Shipbuilding Trades regarding overtime, night shift and holiday work in shipyards, stoppages of overtime and night work on urgent emergency repair jobs have occurred in several districts, while on the North-East Coast an actual strike of the boilermakers has occurred at the works of Smith's Dock Company, Limited. Representatives of the Shipbuilding Employers' Federation and of the Federated Trades are, it is understood, meeting in London to-day—Friday—to discuss the situation, but as the Boilermakers' Union has strongly threatened to withdraw from the Federated Trades rather than yield to the agreement which has been accepted by the other unions which are members of that body, the situation does not appear to offer much prospect of an immediate amicable settlement.

Sixty Years Ago.

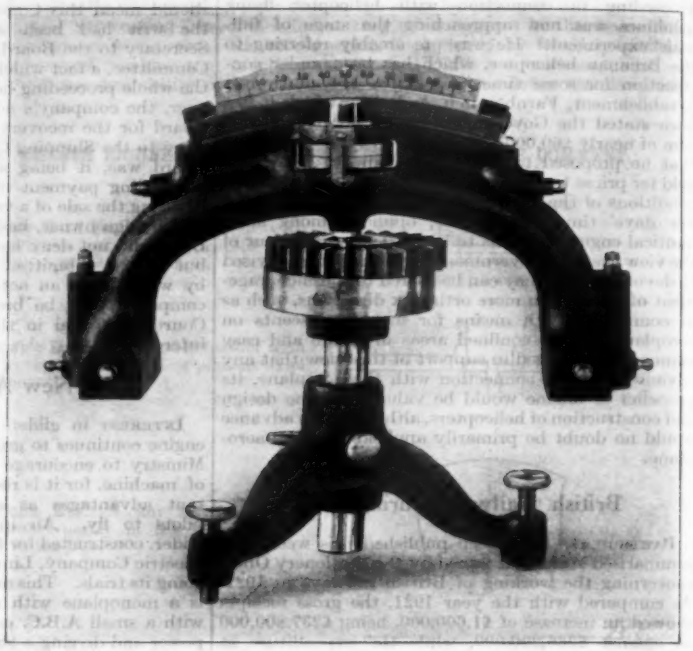
IT is commonly believed that the testing of railway tires by tapping them with a hammer at intervals on a long journey is a mere formality insisted upon by the Board of Trade, but otherwise without practical significance. Whatever may be the case to-day, sixty years ago the breaking of railway tires was by no means uncommon, if we may judge from the fact that in our issue of April 10th, 1863, two separate cases were reported. In one the leading wheel tire of a Great Northern express engine broke, and the train, travelling at 40 miles an hour, was "thrown off the line and dashed to pieces" near Little Bytham. "Almost miraculously," we recorded, "no one was killed, although several of the passengers were more or less injured." In the second case a cattle train of thirty-five wagons on the Chester and Holyhead line was wrecked near Abergele by the breaking of a tire on one of the wagon wheels. "The concussion which followed," our report stated, "sent the greater part of the train across the line, the wagons being piled in a heap of wreck to a height of 40ft." The now familiar "Weston" differential pulley was being introduced in those days. A report which we gave of some trials made with it at Chatham Dockyard was entitled "An Old Invention under a New Name," and was introduced by the statement that "the differential pulley described twenty years ago in Dr. Carpenter's 'Mechanical Philosophy,' who attributed its invention to a Mr. Moore, of Bristol, has reappeared in its original form under the name of 'Weston's patent.'" In our correspondence columns we were taken to task by a Birkenhead firm for having stated that its patent for steam winches had lapsed. In an editorial "tag" to the letter we declared that the patent had been null and void for the past two years, in consequence of the non-payment of the £100 stamp. "The present attempt," we continued, "is even more mendacious than that of certain other parties who are now threatening with the terrors of the law all who may be disposed to avail themselves of an old contrivance known as the 'differential pulley,' but lately patented by an accountant residing in the country."

The "Pendulum" Hardness Tester.

THE familiar methods of testing the hardness of materials are, as is well known, unsatisfactory in several important respects. Of the four principal types of hardness test—the indentation, the impact, the abrasion and the scratch—it may be said that it is more than doubtful whether any pair of them really measure the same fundamental property or group of properties of the material under test. This defect is, of course, a consequence of the fact that it is still impossible to give a basic definition of what we mean by "hardness." Apart from it the various methods have their individual disadvantages. The Brinell and similar indentation tests, for instance, cannot be applied to materials exceeding a certain value in hardness because of the fact that above a definite point the ball or other indenting tool itself suffers deformation. The scleroscope test is also limited in its application, because above a certain hardness the rebound of the hammer becomes unmanageably great unless the "constants" of the instrument are altered, and any change in this respect at once opens the door to doubt as to the comparability of the results obtained from soft and hard substances. The abrasion and the scratch tests are open to the objection that they destroy or injure the specimens to which they are applied and cannot, therefore, be used on parts which subsequently are to be employed structurally. It has been reported that in this respect even the Brinell test is unsatisfactory, cases being on record in which the indentations in hard steel have subsequently developed into cracks. Again, in the Brinell test the harder the material the smaller is the indentation and the more difficult is it to measure its diameter to a given standard of accuracy. The abrasion and the scratch tests show a similar decrease in the quantity to be measured as the hardness increases, the scleroscope alone having a change in the right direction. Finally, although we have by no means exhausted the objections which have been raised against the common forms of hardness test, we may note that in two at least of them the dimensions of the specimen affect the results obtained, the standard Brinell test not being applicable to thin specimens, and the scleroscope rebound being affected by the inertia of the test specimen.

Whether the "pendulum" hardness tester now being placed on the market by Edward G. Herbert, Limited, of Manchester, can be held to overcome all these objections or the more important of them, we shall leave our readers to decide. We can, however, take it upon ourselves to say that it is a novel and most interesting device, and that it appears to open up a wide possibility for the extension of our knowledge regarding hardness and its measurement. It cannot, of course, claim to measure hardness in any less arbitrary a manner than the other devices. Indeed, in this respect it is open to a criticism which cannot to a similar extent be levelled against the established methods, namely, that it itself can be used in two ways, the indications from which may be contradictory to such an extent as to change not only the relative hardnesses of a series of different substances but even the order of their sequence in the scale. Nevertheless, the device has so many interesting and promising features that its idiosyncrasy in this respect may well be overlooked, if indeed that idiosyncrasy is not actually a source of strength rather than a weakness.

The makers have chosen to describe the device as a pendulum, and explain its behaviour in certain particulars as being in accordance with the theory of the compound pendulum. If, however, a compound pendulum is defined in the usual way, namely, as a pendulum, the mass of which is not distributed in such a manner as to permit it to be regarded as being concentrated at a single point, then we cannot quite agree with Messrs. Herberts' view of the matter. The ordinary theory of the compound pendulum, we submit, does not apply to the device, unless that theory is modified first to take account of the fact that the supporting knife edges are not mathematical lines but have dimensions of significant magnitude; and, secondly, to take account of the fact that the amplitude of the swing is not invariably small relatively to the length of the pendulum. Without these modifications the behaviour of the device is contradictory of that expressed by the theory of the compound pendulum. To express its behaviour mathematically, we would require to discuss the dynamics of the rocking-horse.



FIGS. 1 AND 2—THE E. G. HERBERT "PENDULUM" HARDNESS TESTING DEVICE

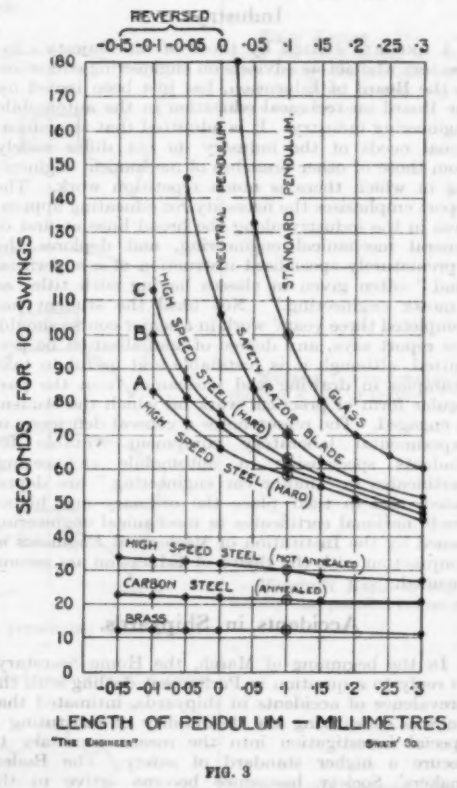


FIG. 3

The device consists, as will be gathered from the accompanying engravings, of a rocker which is placed across the specimen to be tested. The point of support is a ball of ruby or steel fixed in a chuck centrally on the underside of the rocker. The ball has a diameter of 1 mm., and the whole instrument weighs either 2 kilos. or 4 kilos., the two sizes being otherwise identical. Six weights operated by means of screws, are inserted in the body of the instrument in order that the centre of gravity of the device may be adjusted to coincide with the centre of the millimetre ball. Vertically above the ball is a weight operated by a screw. By raising or lowering this weight the centre of gravity of the whole device can be raised or lowered above the centre of the ball by a predetermined amount, as indicated by graduations on the edge of the weight. The only other structural feature of the instrument is a bubble tube and scale mounted on top of the rocker. The scale is graduated from 0 to 100, the zero mark being towards the left and the 50 mark at the centre.

For standard tests the graduated weight is adjusted until the centre of gravity of the whole device lies at $^1/_{10}$ mm. below the centre of the ruby or steel ball—that is to say, it lies $^4/_{10}$ mm. inside the ball. This distance, the dimension between the centre of the ball and the centre of gravity of the device, is called by Messrs. Herbert the length of the pendulum, although for our own part we must regard this term as being inappropriate and somewhat misleading.

There are, as we have already said, two distinct ways in which the instrument can be operated—the scale test method and the time test method. To carry out a scale test, the surface of the specimen is set accurately level, an adjustment facilitated by the provision of a special form of ball vice illustrated in the first half-tone engraving. The instrument is then placed gently on the specimen in an upright position, that is to say, with the bubble divided by the 50 graduation mark. It is thereafter tilted until the bubble is divided by the zero mark and then released. The position of the bubble at the end of the first swing is carefully observed and is recorded as the "scale hardness number" of the specimen. Some typical readings obtained by Messrs. Herbert using a 1 mm. steel ball are here reproduced:—

Scale Hardness Tests.

Plate glass	97	Annealed carbon steel	41
Very hard carbon steel	93	Rolled brass	14
Hard carbon steel	88	Cast brass (soft)	4
Tempered high-speed steel	75	Lead	0
Annealed high-speed steel	54		

It will be seen from these figures that the harder the material the greater is the swing when the device is tilted into a standard zero position and then released. In the case of lead, it will be observed, there is no swing, the device remaining stationary in the initial tilted position.

To take a time test, the device is placed on the specimen with the bubble approximately central at the 50 mark. The instrument is then set oscillating through a small arc by means of a touch with a feather and the period of the swing determined, say, by timing ten swings with a stop watch. Typical time test figures representing the time in seconds for ten swings using a 1 mm. steel ball, are given by Messrs. Herbert as follows:—

Time Test Readings.

Plate glass	100	Annealed carbon steel	22
Very hard carbon steel	75	Rolled brass	15
Hard carbon steel	65	Cast brass (soft)	11
Tempered high-speed steel	52	Lead	3
Annealed high-speed steel	26		

From these figures it will be seen that the softer the material the shorter is the period of oscillation. This striking result is exactly the opposite of what we would expect, arguing from the ordinary pendulum theory, for in a pendulum, simple or compound, friction or other resistance at the knife edges lengthens

the natural period of oscillation. That softness in the material shortens the period suggests, as we shall show presently, a clue to the action of the instrument. It is to be noted that while the time test readings place the materials included in the list given in the same order of hardness as the scale test readings, the relative hardnesses indicated by the two methods are widely different. For example, relatively to glass, annealed high-speed steel and annealed carbon steel are only half as hard on the time test as they are on the scale test, whereas rolled brass is equally hard on both. A diagram is reproduced in Fig. 4, giving some additional results

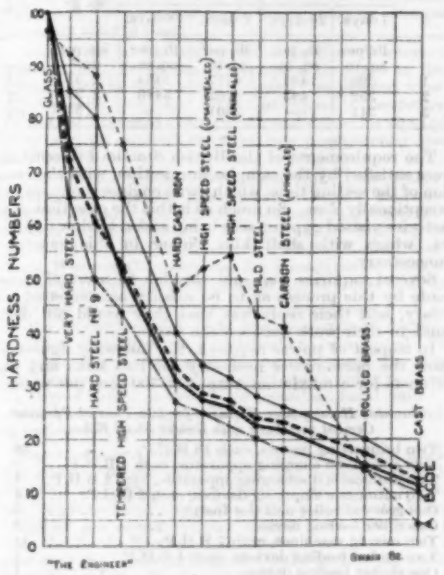


FIG. 4

obtained from a series of metals under five conditions, namely :—

Curve.	Test.	Pendulum.	Ball.
A	Scale	4 kilos.	Steel
B	Time	4 kilos.	Ruby
C	Time	4 kilos.	Steel
D	Time	2 kilos.	Ruby
E	Time	2 kilos.	Steel

A comparison of curves A and C will show that not only has the change from time to scale altered the relative hardnesses, but in this instance has altered the position of high-speed steel in the sequence of hardness. For most purposes Messrs. Herbert recommend the adoption of the time test.

The standard "length of pendulum" is, as stated above, $^1/_{10}$ mm. It is possible, however, to use the device with the "pendulum length" reduced to zero or even made negative—that is to say, with the centre of gravity coincident with or above the centre of the ball. Incidentally it may be remarked that the fact that it is possible to set the device oscillating when the "pendulum length" is zero or negative, shows clearly that the action of the tester does not fall within the range of the ordinary pendulum theory.

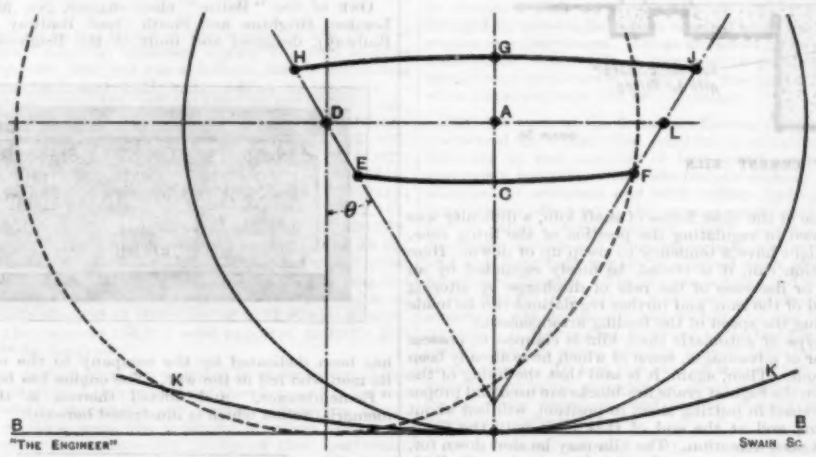


FIG. 5—ILLUSTRATING SUGGESTED THEORY OF THE TESTER

When so altered the device gives a most remarkable result, for it leads to a great magnification of small differences of hardness. As an example, three specimens of high-speed steel supposed to be hardened alike, were tested with the standard "pendulum length" of 0.1 mm., and gave time hardness figures of 57, 58 and 62. When the length was made zero, the hardness figures became 66, 70 and 75, while with a negative length of 0.1 mm., they altered to 77, 85 and 102. In Fig. 3, similar results obtained from eight different specimens, are shown by means of curves. It will be noted that changes in the "pendulum length" scarcely affect the hardness numbers obtained from brass, but as the materials increase in hardness, the effect becomes greater and greater.

Such is the instrument and the results obtained with it, so far as we have been made acquainted with them. It will be agreed that almost at every point the device and its mode of working suggest a question or present a problem. Take, for instance, the figures just quoted for the hardness of three steels when tested with a positive, a neutral and a negative "pendulum length." They seem to us strongly to suggest that the quantity measured by the instrument is a complex of at least two fundamental properties of the metal under test, that one of these factors—the fundamental hardness, let us call it—is constant for all three steels—while the other—the secondary hardness—is dependent upon the precise heat treatment of the metal, and is measured by the instrument differently, according to the position of the centre of gravity. On this supposition the hardness figure for any one of the steels ought to be expressible in the form $a + n\,b$, wherein a is a constant for all three steels, b is constant for any one steel, and n is dependent upon the position of the centre of gravity of the instrument. If a is taken as being 49, n as unity for the normal pendulum, as 2 for the zero pendulum, and as 4 for the negative pendulum, the experimental figures are reproduced with remarkable agreement, as shown below :—

Observed Results.

Pendulum length.	Steel A.	Steel B.	Steel C.
+ 0.1 mm...	57	58	62
0.0 mm...	66	70	75
− 0.1 mm...	77	85	102

Calculated Results.

A.	B.	C.
$49 + 1 \times 8 = 57$	$49 + 1 \times 9 = 58$	$49 + 1 \times 13 = 62$
$49 + 2 \times 8 = 65$	$49 + 2 \times 9 = 67$	$49 + 2 \times 13 = 75$
$49 + 4 \times 8 = 81$	$49 + 4 \times 9 = 85$	$49 + 4 \times 13 = 101$

If the observed figures are plotted against "pendulum length," it will be found that those relating to steel C fall on a curve which has an asymptotic limit of 49. The curves for steels A and B show less definite signs of being asymptotic. We are aware, of course, that it is dangerous to draw conclusions from such limited data, and do not advance this line of thought, otherwise than as suggesting a possible field for investigation.

In connection with the action of the instrument, many questions might be asked. Why does it behave as it does and is its behaviour really dependent upon, and a reflection of, that property of the specimen which we call its hardness? In order to make a contribution to the discussion of these fundamental questions, we will give a brief account of our present views regarding the mode of action of the device.

Let a ball of radius R and centre A—Fig. 5—be placed on a plane, horizontal, perfectly rigid surface B B, and let the centre of gravity of the ball be at C. Let now the ball be rolled to the left through an angle θ, so that the centre comes to D, and the centre of gravity to the point E. An equal roll to the right would bring the centre of gravity to the point F. The path E C F is known to mathematicians as a prolate trochoid, and is a member of the cycloidal family of curves. If, however, we regard it as a circular arc, it will simplify our discussion. For R = 0.5 mm. and A C = 0.1 mm., and for an angle θ of 5 deg. the arc defined by the points E C F will have a radius of 1.6 mm. and a length of 0.07 mm. These figures represent the length and the amplitude of a simple pendulum, which would reproduce approximately the movement of the centroid C. As the distance A C is shortened the arc E C F clearly becomes flatter, until when A and C concide it becomes a straight line D A L. In other words, as A C diminishes the length of the corresponding simple pendulum increases, until with coincidence it becomes infinite. The period of oscillation of the ball may be regarded as approximately proportional to that of the corresponding simple pendulum. Thus as A C is decreased the period of oscillation increases. For this reason, it may be remarked, it is misleading to speak or think of A C as the "length of the pendulum."

With the centroid C coincident with the centre of the ball, the period of oscillation would become infinitely great, that is to say, the ball would cease to show any ability to oscillate at all. If C is raised above A, the path taken by the centroid would be H G J. The ball would, of course, be in unstable equilibrium in the central position, and when rolled to either side would show no tendency to recover its initial position but would tumble over.

If now the surface B B is not plane, but curved as at K K, the path of the centroid C is a curve known as a prolate hypotrochoid, and the circular arc by which we may regard it as replaced is of lesser radius than when the surface B B is plane. The corresponding simple pendulum is also of reduced length and, therefore, the ball oscillates with a smaller period. Moreover, as will be easily understood, the more the surface K K is curved, the shorter will be the period of oscillation of the ball. It will also be appreciated that with the centroid coincident with the centre A, the ball is still enabled to oscillate. In fact, the centroid has to be raised some distance above the centre A before the ball reaches the condition of unstable equilibrium.

From these remarks it will be gathered that the whole action of the "pendulum" hardness tester depends upon the extent to which the ball indents the specimen and rolls out a curved supporting surface for itself. In a very hard metal the curvature produced is slight, the corresponding simple pendulum is of relatively considerable length, and the period of oscillation is great—*c.f.*, 10 seconds for glass. On a very soft surface the indentation and curvature of the surface are considerable, the length of the corresponding simple pendulum is short and the ball oscillates rapidly—*c.f.*, 0.3 seconds for lead.

The explanation of the manner in which the instrument works when used for taking a scale test is fairly obvious, and need not be discussed here. As for the effect on the sensitiveness in detecting small differences of hardness obtained by raising the position of the centre of gravity, a word may perhaps be said. It is clear that if the centroid is coincident with the centre of the ball, the centroid will oscillate in a curved path of substantially the same radius as the curvature of the supporting surface, while if the centroid is below or above the point A, its path will be of lesser or greater radius respectively than that of the surface K K. If we regard, as we may, the hardness of the metal as being represented by the curvature produced in it by the action of the ball, then the object of the test clearly is to measure the radius of this curvature. With the centroid below the centre of the ball, the natural curvature of its path is in the same direction as the curvature produced in the supporting surface, and we have virtually to determine the latter by a process of subtraction. With the centroid coincident with the centre of the ball, the observed figure is a direct measure of the curvature of the surface while with a negative "pendulum length" the two curvatures are oppositely directed, and the process of determination is virtually one of addition.

An Automatic Shaft Cement Kiln.

By HENRY POOLEY, Jun., Assoc. M. Inst. C.E.

THE burning of Portland cement has developed considerably since that commodity was originally manufactured in bottle kilns. To-day, where large outputs of cement are concerned, the consensus of opinion favours the rotary kiln both from the point of view of economy and regularity. But for smaller outputs of, say, 250 tons per week up to as much as 1000 tons per week (maximum) a new method has evolved, and several types of automatic shaft kiln, successful in varying degrees, are working on the Continent, one type of which has already been described in THE ENGINEER on March 17th, 1922. These kilns have developed to such an extent that upwards of a hundred such are in operation to-day, and British manufacturers are beginning to look into the matter themselves.

A type of automatic shaft kiln which appears to have given great satisfaction is manufactured by Messrs. Buhler Bros., Uzwil, Switzerland, and is designed to produce a maximum output of 250 tons per week from one kiln—see sketch. The wall of the kiln may be built of brick, concrete or stone, and the height of the top of the kiln above ground is conveniently about 33ft. 0in., not including the steel chimney, and the diameter in the widest part of the kiln inside the lining is 8ft. 10in. The actual height of the kiln itself, not including the withdrawing apparatus, is about 26ft. The kiln is lined with 9in. of the highest quality fire-brick, backed with approximately the same thickness of lower-grade fire-brick. Between this lining and the masonry of the kiln there should be left a 6in. circular space filled with sand, dried clay, ashes or other insulating material, to conserve as much of the heat in the kiln as possible. Above the kiln is a steel chimney to facilitate the draught. Air is induced through the kiln by means of a fan of approximately 7000 cubic feet of air per minute capacity, which should be capable of running at two speeds giving vacua of 8½in. and 16½in. of water respectively. The reason for two speeds will be explained later.

The raw material, which is treated on the "dry" process, i.e., crushed, dried, finely pulverised, mixed, and proportioned in the dry state, is fed into a hopper alongside of which is situated a second hopper for fuel. This fuel should consist of 50 per cent. anthracite and 50 per cent. coke breeze for the best results. Other fuels, such as a mixture of locomotive ashes and coke breeze, may be successfully used, but they must not contain more than 8 per cent. of hydro-carbons and not more than 18 per cent. of ash with a calorific value of not less than 11,500

B.Th.U. Satisfactory results do not seem to be obtained with high-grade bituminous coal, although attempts are being made with that class of fuel with mixed success. The fuel is not dried or finely pulverised. It is usually put through rolls, and should be about the average size of split peas. Under each of the hoppers there is an automatic weighing machine. These machines are coupled together so that the exact proportion of fuel and raw meal is discharged at the same time into a common chute. The proportion of fuel required for burning when a mixture of 50 per cent. anthracite and 50 per cent. coke breeze is used, is found to be in the neighbourhood of 17.5 per cent. of the clinker produced, or, say, 3½ cwt. of fuel per ton of clinker, and may under favourable circumstances be considerably less. The mixture of fuel and raw meal is elevated to a worm conveyor which serves to mix the ingredients further. Water is next added in an open mixing trough to the extent of about 10 per cent., but this figure varies with the physical nature of the raw materials used for manufacture. The trough feeds a briquetting press in which briquettes are formed under a pressure of about 200 kilos. to the square centimetre—just about 1½ tons per square inch—but again this figure varies with the nature of the raw material. For example, with blue lias limestone and shale a lower pressure is needed, while a higher is required for most blast-furnace slags and limestone used for the manufacture of slag Portland cement. Arrangements should be made to allow air to escape from the briquette, which otherwise might be a source of trouble.

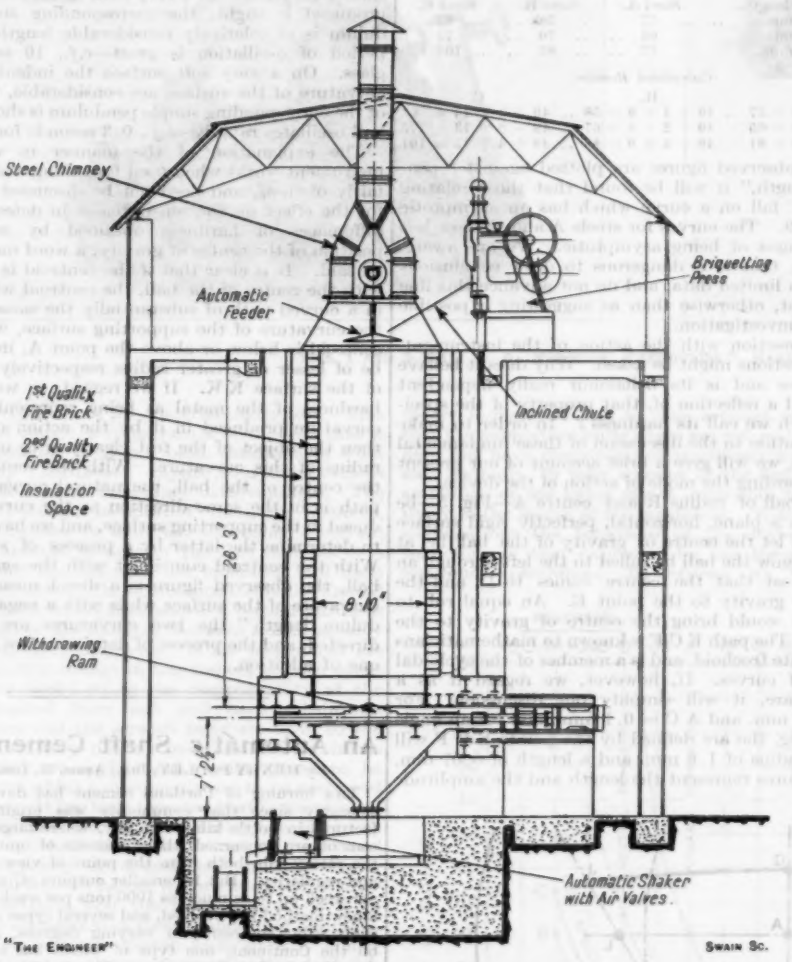
In order to keep the maximum feed to the press, a most important matter, so that the moulds may always be full, an excess of damped mixture is fed to the press and the overflow is returned. This enables the man in charge to see that his press is always working with a full feed.

The briquettes are automatically pushed along an inclined slide and fed on to an umbrella-shaped feed table which rotates and is inside the steel chimney, centrally over the kiln and arranged on a level with the mouth. The table is perforated to facilitate the draught which might otherwise tend to be choked in passing between the periphery of this table and the kiln wall. An arm rotates automatically over the surface of the feed table, pushing off the bricks and distributing them evenly in the kiln. The arm can be set so as to feed any one side of the kiln more than the other in case, as sometimes happens, the kiln is burning more on one side than the other. The temperature of the escaping gases is not higher than 200 to 300 deg. Fah., and does not interfere therefore with the satisfactory working of the feed table. Incidentally such a low temperature indicates that most of the heat is conserved in this process, and this fact partly accounts for the low fuel consumption. An important point to note is that the briquettes must be so made that they will not fall into powder when dropped from the feed table on to the surface of the contents of the kiln, a distance of about 2ft. or 3ft. If powder were formed, the draught would soon become choked and quantities of raw material blown away.

The first 5ft. to 6ft. from the top of the kiln downwards form a drying zone in which also a portion of the carbon dioxide is driven off. The next 5ft. form the calcining zone, while the remaining 13ft. to 14ft. form the cooling portion. To avoid hanging up of the clinker to the sides, the lining of the kiln is stepped, the lower portion being of a slightly larger diameter than the upper. It is estimated that in a kiln of this size the material takes about four hours to pass the drying zone, four hours the calcining, and about sixteen hours the cooling zone.

The base of the kiln is furnished with an iron ring about 12in. to 18in. deep, which covers the lining and protects it against the grinding action of the withdrawing ram. This ram is in the form of a large rasp, and moves slowly backwards and forwards in a horizontal direction across the bottom of the iron ring, and above the bars which form the bottom of the kiln. It makes three or four complete movements backwards and forwards in an hour, and the reversing of the direction is automatic. The whole is worked hydraulically, and absorbs about 2 horse-power per 40 tons of clinker in twenty-four hours. The ram squeezes and crushes the blocks of clinker against one another and against the iron ring, and it discharges the clinker in this way in a remarkably regular manner. This discharge is said to be quite as regular as that from a rotary kiln. The size of the clinker coming out varies with the distance apart of the bars, and the best results are obtained when the bars are set about 3in. to 4in. apart.

The clinker falls into a specially constructed shaker conveyor, which is furnished with a double air valve to allow both of the discharge through it of clinker, and the passage of air in the opposite direction. The clinker coming out of this conveyor is cool enough to hold in the hand, which is a second indication that most of the heat in the kiln is being conserved.



THE BUHLER AUTOMATIC SHAFT CEMENT KILN

In some of the older forms of shaft kiln, a difficulty was experienced in regulating the position of the firing zone, which might have a tendency to creep up or down. Here the position can, it is stated, be nicely regulated by an increase or decrease of the rate of discharge by altering the speed of the ram, and further regulations can be made by altering the speed of the feeding arrangements.

This type of automatic shaft kiln is claimed to possess a number of advantages, some of which have already been pointed out. Then, again, it is said that the lining of the kiln, when the highest grade fire-blocks are used and proper care exercised in putting them in position, will last about two years, and at the end of that time only the firing zone will need attention. The kiln may be shut down for, say, twenty-four hours and started up again with little variation in the quality of the clinker. It is for these periods of shutting down and starting up again that two speeds are necessary with the induced draught fan, and when the average output of the kiln is slackened off. The kiln is said to be capable of quite a considerable reduction on its maximum output of 250 tons per week. This can be reduced to 200 tons or even less without materially effecting the quality of the clinker.

Shaft kiln clinker requires less power to grind it into "flour" than rotary clinker. While grinding with a specific amount of power, if 100 lb. of "flour" is produced from rotary clinker, the same amount of power will yield 125 lb. of "flour" from shaft kiln clinker with at least the same degree of fineness. One of the main points to consider in connection with automatic shaft kiln clinker is the quality and regularity of the clinker produced. There is considerable controversy as regards this point, and some personal observations of clinker produced in several Swiss works may be of interest.

The amount of under-burnt clinker produced at the factories visited using this type of automatic shaft kiln was about 3 per cent. to 4 per cent. (maximum). At times the proportion under-burnt appeared to be considerably less. At one factory one boy was employed to pick the clinker from five kilns each producing 200 tons per week, which seems to indicate that the actual quantity is small.

Tests were seen, made by the National Laboratory at Zurich, three samples* of which are here given:—

Three Parts Sand to One Part Portland Cement.

Sample	Strengths. Tensile. 7 days.	Tensile. 28 days.	Compression. 7 days.	Compression. 28 days.	Density. sp. gr.	Expansion.
	lb. per sq. in.	lb. per sq. in.	lb. per sq. in.	lb. per sq. in.	kg. per dm³.	mm.
1	390	464	4317	5453	2.33	nil
2	352	483	3763	5410	2.34	nil
3	341	—	3601	—	2.33	nil

The requirements of the British Standard Specification were satisfied by the samples in question, with the exception of the setting time, which Swiss engineers require to be exceptionally slow. So much so is this the case that at the factories visited gypsum was being added to slow down the set, which with shaft kiln clinker in this country is unnecessary.

Several inquiries were put through to users of cement made by this process as to its quality as compared with rotary, and their reply was that they would not distinguish in their work between the two.

In respect of power required, the following figures will show the horse-power necessary for two kilns and their adjuncts for a maximum output of 500 tons per week:—

Running Horse-power Required for 500 Tons of Portland Cement per Week with Buhler Shaft Kilns.

Two briquetting presses, each 18 B.H.P.	36
Two automatic charging apparatus, each 1 B.H.P.	2
Two automatic discharging apparatus, each 2 B.H.P.	4
Two automatic emptying devices, each 2 B.H.P.	4
One grooved roller mill (for fuel)	5
One roller feeding device	2
Two mixing machines, each 7 B.H.P.	14
Two shaker feeding devices, each ½ B.H.P.	1
One shaker feeding device	1
Two high-pressure fans, each 14 B.H.P. (maximum)	28
One elevator for raw meal	1.5
One elevator for fuel	1.5
One elevator for mixed raw meal and fuel	2
One worm conveyor (overflow from press)	1
Total maximum horse-power required	103

The writer's strong impression, after a careful study of the subject, is that for small outputs of cement, a type of kiln similar to that described is advantageous. It is possible, and is often seen on the Continent, to convert old Schneider, or other suitably shaped kilns, to this type and thus increase their output and the quality of cement. A disadvantage of the new kiln is the non-advisability of using bituminous coal. In so many places that type of fuel is cheaper and more procurable than the mixture of 50 per cent. anthracite and 50 per cent. coke breeze; but it is possible that a way will be found in the near future to overcome this difficulty. Speaking generally, however, the writer considers that the new type of kiln deserves the very careful attention of manufacturers, since, if continental results are any criterion, satisfactory and cheaper cement can be produced by it than by other methods, which to-day is an important consideration.

The Locomotive "Remembrance."

One of the "Baltic" class engines, No. 333, of the London, Brighton and South Coast Railway (Southern Railway), designed and built at the Brighton Works,

has been dedicated by the company to the memory of its men who fell in the war. The engine has been named "Remembrance," and affixed thereon is the bronze memorial tablet which is illustrated herewith.

A scheme, involving the expenditure of between £2,000,000 and £3,000,000, is to be carried out by the Marconi Company, in order to provide a chain of powerful wireless stations. What is practically a new wireless town is to be erected in England. There are to be six stations grouped together for the purpose of communicating with as many different parts of the world, or, alternatively, being devoted to one point, where for any reason there is a "rush" period. The minimum transmitting capacity for the combined stations is to be about 35,000 to 40,000 words per hour. The site of the new stations has not yet been decided, but Marlborough Downs is suggested. All that is now required is the Government licence.

* These samples were prepared according to the rules required by the Swiss authorities and the results must be judged accordingly.

Railway Matters.

THE first annual report of the Railway Rates Tribunal for the year 1922 has been published, and copies can be obtained, price 1s., at H.M. Stationery Office.

THE Financial Secretary to the Treasury told Mr. Lambert on the 27th ult. that none of the locomotives built at Woolwich had yet been sold, but that particulars had been very widely circulated to probable purchasers, and negotiations for sale were in progress.

COMMENCING in July a "Pullman Limited," of first and third-class cars, will run between London, Leeds and Harrogate by the London and North-Eastern Railway. The days of competition between railway companies evidently are not past.

ACCORDING to the answer given by Earl Winterton on March 22nd, the Indian Government proposes to float a further loan in this country during the present year for development purposes. The estimated expenditure in 1923–4 for imported rolling stock and stores for the Indian State and guaranteed railways was provisionally put at £17,750,000.

THE Shrewsbury and Welshpool Joint Line enters the Cambrian section of the Great Western Railway at Buttington, and the London, Midland and Scottish has running powers thence to Welshpool. The 4½ miles beyond Welshpool to Forden are single-tracked, and the Great Western Company has let a contract to Jackaman and Sons, of Slough, to double the line at a cost of £70,000.

THREE hundred and thirty-one suggestions were made by the Underground staff to the management during the month of March, thirty of which are to be adopted. These included the following:—(1) Improvement to guard's hand lamps; (2) improved boiler tube cleaning rod guide; (3) use of stainless metal for omnibus hand rails; (4) method of extracting chokes from carburetters; and (5) an improved type of tramway ticket.

MENTION has on more than one occasion been made in this column of the unfortunate line between Streatham Junction and Tooting and Merton-road, which has been left "high and dry" since the London and South-Western withdrew its steam-worked trains from Ludgate Hill over the South-Eastern and Chatham to Tulse Hill and then over the London, Brighton and South Coast through Streatham. The Southern Railway Company has now informed the Ministry of Transport that it is considering the restoration of this service in connection with the electrification of the South-Eastern section.

SOME large contracts for the construction of electric locomotives are at present in progress in France. La Société des Constructions Electriques de France, which has lately completed an order for fifty for the Midi Railway, has just received a further contract for forty engines for the Montrejeau-Pau section of the same railway. The joint concern known as the Société d'Etudes pour l'Electrification des Chemins de Fer, which comprises the Ateliers de Construction du Nord et de l'Est, and the Schneider and Thomson-Houston companies, has also lately received orders for eighty electric locomotives for the Paris-Orleans Railway Company, and for thirty for the Paris, Lyons and Mediterranean Railway.

A SECOND reading has been given to a Bill for the amendment of the Railway Fires Act, 1905, so that the maximum liability of the railway companies shall be raised from £100 to £200. From a locomotive engineering point of view, the debate was made interesting by a speech by Mr. H. S. Charlton, the Labour member for Leeds South, and a prominent member of the Associated Society of Locomotive Engineers and Firemen. He attributed spark emission largely to valves and pistons becoming worn, with the result that the driver had to work his engine more heavily, and there was a greater draught of air through the fire. He thought the Bill should be withdrawn and the railways and farmers compromise to have strips of land sown with root crops.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the two months ended February 28th last was as follows, the corresponding figures for 1922 and 1921 being added in brackets:—Locomotives, £615,435 (£1,435,859, £1,107,915); rails, £341,071 (£656,589, £888,929); carriages, £272,581 (£231,004, £215,165); wagons, £414,979 (£1,064,409, £949,057); wheels and axles, £113,501 (£246,027, £393,487); tires and axles, £64,698 (£117,115, £294,431); chairs and metal sleepers, £81,260 (£378,060, £359,554); miscellaneous permanent way, £186,995 (£312,147, £521,019); total permanent way, £787,525 (£1,709,938, £2,457,420). The weight of the rails exported was 35,101 tons (54,101 tons, 33,290 tons) and of the chairs and metal sleepers 7400 tons (23,712 tons, 14,565 tons). During the month of February, 1923, locomotives to the value of £84,718 were shipped to India and of £152,970 to Europe. Rails to the value of £64,071 were exported to India and of £47,588 to Australia.

A GOOD deal of what we consider is unnecessary alarm has been displayed this week over the proposed reduction in the railway shopmen's war bonus. There are about 110,000 of these men, the minority of whom belong to one or other of twenty-eight unions of their particular craft, and the majority to the National Union of Railwaymen. These shopmen enjoyed the bonus of 16s. 6d. given to those in the engineering trades, but when the railway companies proposed to take away the bonus by three instalments of 5s. 6d. each, as done in the engineering shops, the non-railway unions took the case to the Industrial Court, which decided—see page 245 of THE ENGINEER of September 5th last—that railway shopmen were in a different category from those in engineering shops. The men, however, as related on page 327 of our issue of September 29th, subsequently accepted a reduction of 10s., and the companies now are wishful to dock the further 6s. 6d. The talk of trouble on the railways has arisen from a delegates' meeting of the N.U.R., which said that it would not negotiate with the companies, and that if the reduction was made there would be a strike. On Monday night Mr. J. H. Thomas urged that the case should go to the Railway Wages Board, and it will probably do so.

Notes and Memoranda.

A RECENT comparison, cited by *Canada*, points out that whereas the famous Great Boulder Mine, of West Australia, produced 190 tons of gold in its lifetime, the Hollinger Mine, in Northern Ontario, has already produced over 100 tons, has not yet reached anything like its maximum annual production, and has, apparently, a long life still ahead of it.

THE new power station to be erected on the Muskingum River at Philo, Ohio, about nine miles south of Zanesville, is to include two 35,000-kilowatt turbines; which will be operated with steam at a pressure of 530 lb. per square inch and a total temperature of 725 deg. Fah. at the turbine throttle. The Babcock boilers will be built for 650 lb. working pressure.

As an experiment the steel framework for the ceilings of a large office building in Toronto was recently welded together, in place, by the electric arc method. The framing comprised 1¼in. by 1¼in. angles, as principal members, with ½in. square bars spaced at 12in. centres. The work, according to the *Contract Record*, was all done by four men, including one welder, who averaged about 135 welds per hour, or nearly 1100 welds per day.

THE research conducted by Professor Barton Scammell—president of the Radium Institute at Dover—on the analysis of lava from Mount Vesuvius, now being used as a fertiliser, has, according to the *English Mechanic*, led to the discovery that the layers of "bind," the substance found at the top and bottom of coal seams, are identical in analysis with lava. The "bind" contains lime, iron, soda, magnesia, potash, and other elements required by plant life, and when made radio-active with solutions of radio-phosphate of potash, it absorbs nitrogen from the air and forms a perfect fertiliser.

ZINC chloride, although it is one of the most efficient preservatives for wood, suffers much loss if the wood is exposed to water, which causes a decomposition of the salt, removing material amounts of chlorine. Samples of preserved wood analysed after service were found, according to the *Journal* of the Franklin Institute, to contain zinc equivalent to 0.4 and chlorine only sufficient for 0.08. In examining treated wood, therefore, it is important to determine the chlorine as well as the zinc, since it is the chloride and not the zinc alone which gives protection. Even then some of the chlorine must be considered liable to be in the form of an insoluble compound.

IN the course of a recent lecture before the Birmingham Municipal School, Mr. R. S. Morrell said that the durability of paints depends to a great extent on the nature of the medium used, just as the durability of varnishes depends on the quality of the oils used and also on the amount and quality of the resinous components. In the case of paints the effect of the pigment is perhaps less than the effect of the resin in a varnish on the durability. It would appear probable that if polymerisation or union between molecules of the components has occurred before oxidation of the oil, that the oxidation product may be considerably stabilised towards weathering agencies, besides having a slightly higher refractive index, and, in consequence, a better lustre. Experience has shown that full-bodied polymerised oils give more durable media in either a paint or varnish, whether the oil be linseed oil or wood oil.

THE concluding sentence of an article on the "Present and Future of Marine Engineering," in *Nature*, suggests that the whole practice of marine engineering is, as it were, in the melting-pot, and what the standard form of marine propulsion will be in the future is difficult to see. Given trustworthiness, it is economy which has the deciding influence; economy in weight, economy in space, economy in upkeep, economy in fuel. What the continual striving after economy has done in the past can be judged by the fact that, fifty years ago, to convey 100 tons of cargo a mile, required 18 lb. to 20 lb. of coal; to-day the same result is obtained with 1½ lb. to 2 lb. of oil. Finality was thought by some to have been reached when the compound engine was introduced. Great advances have been made since then. But while it may not be possible to effect revolutions on the scale of the past, the time is far distant when improvements will be impossible.

RECENT work at the American Bureau of Standards has discovered an unidentified constituent of relatively great hardness in two samples of high-speed steels. It had previously been found that electrolytic etching with weak solutions of ammonia and with sodium hydroxide has a very similar effect upon the various constituents found so far in alloy steels—namely, both solutions darken chromium carbide and tungsten carbide, while iron carbide and iron tungstide remain unaffected even after etching for several minutes. The new constituent did not respond to the test for iron carbide and iron tungstide and did not assume any shape usually met with in the case of tungsten carbide. It did respond, however, to the test for chromium carbide, and it seems possible that it may be a carbide of vanadium. To test this idea an iron-carbon-vanadium alloy is now being prepared for study wherein it is hoped to have the vanadium and carbon present entirely as vanadium carbide.

AT a recent meeting of the Boston Section of the American Society of Mechanical Engineers, Mr. J. R. McDermot read a paper on the corrosion of boilers, in the course of which he stated that the maximum amount of dissolved oxygen usually present in boiler feed-water is not more than about 0.6 cubic centimetres per litre, but that corrosion can easily take place in very large boilers with water only containing 0.15 cubic centimetres per litre. It has been found as the result of exhaustive experiments that when water is de-aerated by means of degassing plant and the oxygen reduced to 0.025 cubic centimetres per litre, then no corrosion at all takes place, but it is not safe to exceed this figure. As regards the electrolytic action of dissolved salts in feed-water, it is stated that ordinary inorganic salts in order of the severity of their action are as follows:—Nitrates, chlorides, sulphates, chromates, and arsenates. It is, of course, impossible to separate these salts from boiler feed-water except by the expensive method of distillation, but in very bad cases special electrical apparatus can be installed.

Miscellanea.

THE Dutch Indies last year exported rubber to the extent of 104,027 tons, compared with 73,401 tons in 1921 and 76,750 tons in 1920.

THE machinery for the 1,000,000 horse-power power plant on the Saguenay River, Quebec, is to be manufactured by a Canadian firm.

WORK on the 10,000,000 bushel grain elevator at Montreal will be commenced at once. The first unit is expected to be completed before the 1923 navigation period is over.

A SCHEME is on foot for establishing zinc works in Sardinia capable of producing 6000 tons of zinc per annum. When this plan is carried out and the existing Italian works have completed certain extensions which are now in progress, it is estimated that Italy will be independent of foreign supplies.

A LARGE creosoting plant will shortly be established at Cochrane, Ontario, for the treatment of railway sleepers by an English firm. A site has been secured for the plant, and contracts with the Canadian National and T. and N. O. Railways for creosoting sleepers are either signed or under negotiation.

THERE are, according to the *Times*, many evidences that there will be a gold rush to Labrador in the spring. It is stated that two development companies have already registered thousands of acres of land along the three rivers flowing into the Stag Bay, and it is believed that the bay will be a second Klondyke. As yet there is no evidence to justify these extravagant expectations.

SOME time ago the discovery of iron ore (hematite) was reported from the State of Johore, the most southerly portion of the Malay Peninsula. Advance figures for mineral exports during the past year have just come to hand from official sources, showing that 111,367 tons of iron ore were exported and 1490 tons of tin ore. In 1921 the export of iron ore from Johore amounted to 74,250 tons, valued at £86,635. The whole of this ore went to Japan.

IN consequence of a rumour recently current that the Federated Malay States Government had disposed of its stocks of tin held under the Bandoeng Agreement, the Malay States Information Agency is authorised to state that there is no truth in such rumour. As has been already announced, the Government of the Federated Malay States has no intention of selling its stocks of tin otherwise than in small quantities to meet the consumptive demand whenever attracted by suitable prices.

THE contract for the construction of the Kenogami dam, one of the most important hydro-electric developments in the Province of Quebec, has been awarded to the Nova Scotia Construction Company, Limited, and work on the structure will be commenced shortly. The contract price is 985,682 dollars, and the expropriation of the area to be flooded will cost about 800,000 dollars. The total outlay is estimated at two million dollars. The work will be in charge of Mr. O. Lefebvre, C.E., Chief Engineer to the Quebec Streams Commission.

IT is the intention, in connection with the International Gas Exhibition which the municipal authorities of Amsterdam are organising to be held from October 13th to November 11th next, to collect exhibits demonstrating the use of gas for industrial purposes in large and small concerns, *e.g.*, metal works, chemical works, food-preserving factories, restaurants, cycle factories, vulcanising plants, central heating systems, for the practical use of doctors, dentists, bakers, &c. Household and scientific appliances employing gas as fuel will also be welcomed.

EVIDENCE given before a Royal Commission indicates that shipbuilding in Canada is at a very low ebb. Mr. J. L. Perron, representing the shipbuilding companies, said that since the Government building programme had been completed, very little had been done in the Canadian yards. Four yards had gone out of existence, and the remaining ten were mostly occupied by repair work. Only two or three ships, he added, had been built during the past year. It was pointed out by a commission's counsel that the fact that some thirty vessels for the Lake trade were being built in Britain, indicated that they could be constructed more cheaply in the Old Country than in the Dominion.

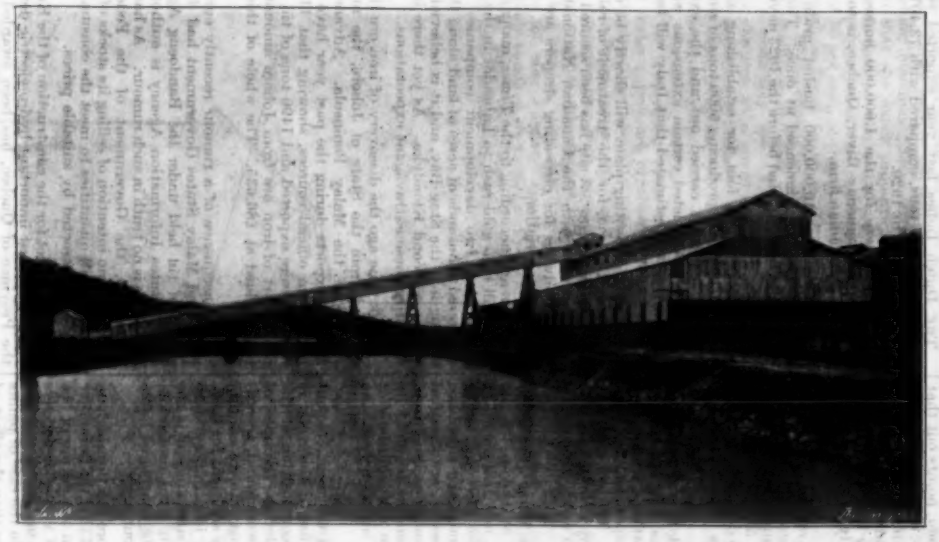
THE new hydraulic pressure tunnel of the Niagara Falls Power Company, which has cost some £500,000 to drive, was opened for public inspection on March 26th. The tunnel, which is 4300ft. long and has a diameter of 32ft. inside its 2ft. concrete lining, runs from an intake on the upper river, half a mile above the falls, to another intake on the banks of the lower gorge. The tunnel will carry a volume of water sufficient to operate three hydro-electric power units, each of 70,000 horse-power capacity, in the power-house addition below the gorge bank. Construction was started on April 25th, 1921, under a licence given the company by the Federal Power Commission to divert 19,500 cubic feet of water from the Niagara River for the development of power. Water will, it is said, be turned into the tunnel within a few weeks.

THE statistics of iron and steel production in France during February, which have recently been published, show a notable decline, as was to be expected. Since the beginning of the year 40 blast-furnaces have been damped down, 26 in January, 12 in February, and 2 in March. The production of pig iron in February was barely over 300,000 tons, as compared with 480,000 tons in January and 510,000 tons in December. For steel, the February production was 290,000 tons, as against 407,000 tons in January and 415,000 tons in December. It is true that some improvement is now taking place. Two or three blast-furnaces have been restarted in Lorraine. Although very irregular, the arrivals of coke from the Ruhr are not negligible, the average arrivals from that source amounting to 500 tons per day. The first arrivals of Belgian coke are reported, while the price of British coke has weakened slightly, mainly through the movement of the exchange. It is thought, however, that the receipt of American coke may accentuate this weakening.

MECHANICAL HANDLING EQUIPMENT AT THE RISDON ZINC RECOVERY WORKS, TASMANIA

(For description see page 398)

THE WHARF WITH PILES OF SLAB-ZINC AND RESIDUES



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PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement a Two-page Plate illustrating the German Submarine Cruisers U 139 to 141. Every number as issued by the Publisher contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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DEATH.

MARCH 26TH, at Cavendish House, 29, Wickham-road, Brockley, London, S.E., WALTER HENRY WILLCOX, governing director of W. H. Willcox and Co., Limited, of 38, Southwark-street, S.E. 1.

THE ENGINEER.

APRIL 13, 1923.

The Generation of Electricity in Great Britain.

THE Electricity Commissioners have just published a return of the fuel consumed and the units generated in the power stations in Great Britain during the year ending March 31st, 1922. This document is of considerable interest, and the extracts from it which we publish on page 401 may be commended to our readers' attention. It may be remembered that in the second annual report of the Electricity Commission it was stated that a more satisfactory position could be recorded in respect of the four-weekly returns of the fuel consumption, &c., which all authorised undertakers are required to render, and which are also submitted voluntarily by a number of railway and tramway authorities and by non-statutory undertakings owning generating stations. During the period which that report covered the Commissioners received returns in respect of every generating station owned by undertakers in Great Britain, and also from all the tramway and light railway stations and practically all the railway companies possessing stations. Only in a few cases were difficulties experienced in obtaining regular reports. But we note that the work of compiling the present publication has been hampered to some extent by the failure of certain power station engineers to declare the calorific value of the fuel consumed. Apparently a number of these engineers have little knowledge of what the heat value of the fuel they use really is, or at any rate they have failed to convey this information to the Commissioners, who have therefore been compelled in certain instances to adopt average values. It is surely time that all who run electricity supply stations had means of testing their coal. For comparison purposes it is obviously unfair to specify results in terms of pounds of coal per unit generated, for different coals have, of course, different heat values. A calorimeter is not a very expensive piece of apparatus nor a difficult one to use, and it is to be hoped that in future the Commissioners will not have to complain of inadequate information of this description. Many of the electricity supply undertakings have in the past failed in the direction of making measurements which are necessary in order to run their plants under proper conditions, some even working without CO_2 recorders. However, there is no question that there has been marked improvement within recent years. With coal at double and more than double its pre-war price, fuel economy is no longer a matter that can be treated with more or less indifference. Coal is far and away the most commonly used fuel for the production of electricity.

Nearly four thousand nine hundred million units of electricity were generated in public stations during the year ending March 31st, 1922, and with the exception of a little over three per cent. they were all distributed from steam stations. Next to coal comes waste heat, but during the period covered by the return the units produced by waste heat plants only amounted to something under fifty-five millions, or 1.12 per cent. of the total output. Refuse destructors only contributed 0.36 per cent. of the year's production, gas engine producer plants 0.31 per cent., town gas plants 0.08 per cent., oil-driven plants 0.65 per cent., and water power 0.59 per cent. Some of the small stations using gas and oil show very good results, but it must always be remembered that such stations often run under conditions which are not applicable to larger stations. Batteries can be charged up and the machinery stopped at times of light load so that the plant can be run under the best conditions. As will be seen from Table II. printed on page 401 and abstracted from the return, which is obtainable from the Electricity Commission at Gwydyr House, Whitehall, S.W. 1, the highest thermal efficiency for a steam plant during the year was 17.2 per cent., whilst that for gas and oil—see Tables III. and IV.—was 15.6 and 29.15 respectively. Needless to say, even the best stations leave a good deal to be desired, but with present methods of generating electricity the thermal efficiencies obtained in many instances are to be regarded as good. Further improvements upon the highest figures depend upon scientific and technical developments rather than upon the management of generating stations. Speaking at a meeting of the Institution of Electrical Engineers some time ago, Mr. W. M. Selvey said that a 25 per cent. thermal efficiency steam station was in sight, but up to the present time that station has not materialised. The return, read in conjunction with its predecessors, leaves no doubt that the conditions under which electricity is generated are steadily improving and that the colossal waste of coal that has been going on for many years is being reduced. The thermal efficiency of over 17 per cent. reached by the best steam station—Carville, no doubt—is well above what would have been regarded as within the bounds of possibility a score of years ago, and shows, not only what has been achieved by the steam turbine, but, still more, the advance that has been made and is still continuing in the design, control, and handling of steam boilers. But it would be a mistake to suppose that results of this order can only be secured in vast power-houses. We have no hesitation in saying that, were relatively small power stations run with the same care and directed with the same breadth of outlook, an equal efficiency could be attained. The small companies frequently strike at initial expenditure which in the long run would rapidly repay them. The cost of equipping a battery of, say, half-a-dozen boilers with adequate control equipment would amount to something like £1200. That appears a very serious outlay to the small companies, and it is only by the education they derive from such returns as that before us that the men who direct such companies—men frequently with no technical knowledge and a parochial outlook—are likely to be induced to accept the recommendations of their engineers. The publication of these returns by the Electricity Commissioners is unquestionably an excellent scheme, for they throw much light upon relative efficiencies. In a long table towards the end of the publication—far too long for us to publish—a comprehensive summary is given of the best results as regards fuel consumption per unit generated and also the overall thermal efficiency for each class of station, not only in respect of its own area and group, but also in relation to the stations in other areas and groups, and the value of this table scarcely needs emphasising.

The return is, of course, in no way concerned with the cost of generation and distribution, which, after all, is the most important matter from the point of view of the consumer. High thermal efficiency is certainly a thing to be aimed at, but the price which the consumer pays for his current is naturally also governed by other factors. Hence the electricity supply problem has to be viewed from other standpoints besides that of units generated per pound of coal of a specified calorific value. Cheap supplies are needed to make electricity popular, and without them the "all-electric

age" will never materialise, and to secure that end as much attention must be devoted to other aspects of the problem as is now being given to the reduction of fuel consumption. We are aware that the publication of these annual returns has already had an admirable effect in stimulating a healthy rivalry between power supply companies, which are now striving to do their best.

Water in Coal.

In very few contracts made for coal is any reference made to water, or moisture, as it is usually termed in the case of other materials, such as metallic ores carried in bulk. A notable exception, however, is to be found in the specifications issued annually by the War Office for coal required by the several home commands. These specifications have reference to different qualities of coal—house coal, steam coal, slack, &c.—and in each case the maximum amount of water permitted is stated. In the case of many products the determination of moisture is made by standardised methods on bulk samples, as a grab sample taken haphazard would obviously be unreliable. Work of this sort, which has to be done by an expert, naturally costs money, and it is on that account, in great measure, that nearly all the coal, even when carried in open wagons, is sold without any regard being paid to its moisture content. One rarely hears complaints of excessive water, though instances of contracts being broken for excess of ash or deficiency in calorific value are not unknown in the coal trade. Unlike ash or dirt, water escapes the notice of the user, and therefore is most unlikely to form the basis of a complaint. Indeed, in so far as an excess of moisture diminishes the rate of combustion, it enjoys a wholly unwarranted commendation in the careful household, where the fact that water is being paid for at the rate of coal is easily overlooked.

The occurrence of water in coal generally is universal. It may be as low as one-half per cent. in some anthracites and cannels, and it may rise to 14 per cent. in certain outcrop coals, leaving brown coal and lignite out of consideration. Although there are, or have been, certain Staffordshire coals on the market with 8 to 11 per cent. of water, a common figure throughout the country is 3 to 5 per cent., figures which will naturally be higher after exposure to wet weather. The curious thing about the outcrop coals containing 12 to 14 per cent. of water is that to appearance and touch they show no signs of such great water content, being dry and brittle. As a rule—owing to their low calorific power—they are not mined, but there have been cases where purchasers have been quite mystified by the poor results obtained. Possibly the action of the War Office, which buys at keen competitive prices, in fixing a maximum water content is intended to be a safeguard against the unauthorised supply of coal of normally high water content; but the increasing sale of late years of washed coal for specific purposes has led to the necessity of arrangements about water being come to between buyer and seller. In the case of washed nuts, supplied now on a large scale for gas making, the water generally runs about 10 per cent., but it is now a common thing for the seller to contract to supply 22 cwt. to the ton and thus to free himself from any subsequent complaint as to excessive water. This arrangement has been found to work with less friction than selling on a basis of, say, 10 per cent. water with penalties for excess. With regard, however, to washed slack for coke making, the ordinary procedure is to contract on a basis of 15 per cent. water with penalties for excess, it having been found that if the water exceeds 15 per cent. the temperature of the coke oven is lowered too much. A good deal depends upon the time allowed for the washed slack to drain at the washeries and, naturally, the state of the weather during transit is a factor of importance. It is, of course, usual in careful reports to estimate the efficiency of steam boilers in units of "dry" coal, that is to say, a kind of coal which—neglecting anthracites—can never be used in practice; but when it is remembered that—according to Kent—a deduction of "upwards of 4 per cent." must be made from the possible efficiency owing to the normal content of water, the necessity of paying attention to the abnormal content of water becomes obvious. We have to consider, not only the actual loss of heat in converting the moisture into steam, but the collateral losses which occur in boilers when they are fired with fuels having a low calorific value per pound as burned. The whole question is one that will bear further investigation now that more scientific interest is being exhibited in boiler management. An important paper on the properties of water in coal was issued a few years ago by the United States Bureau of Mines—in which, by the way, discrimination between "free" and "combined" water is suggested—but as far as we can recall the subject has not been followed up in this country. It is one worthy of the attention of the Fuel Research Board.

The ordinary method of estimating the water in coal is by exposure to heat in an air oven, but it has long been known that it lacks accuracy owing to the fact that most coals increase in weight to a greater or less extent on heating owing to oxidation, and a recent research has shown that at the end of 1400 hours' heating a sample of coal showed an increase in weight of no less than 5.97 per cent. on the original weight. The commercial analyst would obviously never carry out tests of that duration, and the time-honoured method enabling a result to be arrived at speedily is likely to continue in use, despite the recent publication of more exact but more complicated methods. *Apropos* of this point, it may be mentioned that last year the Fuel Research Board of the Department of Scientific and Industrial Research appointed a strong committee to advise upon the sampling and analysis of coal, and the methods recommended are to be adopted in the physical and chemical survey of the national coal resources being organised by the Board and the Geological Survey.

Obituary.

ARTHUR T. ST. LAURENT.

The death is announced as having taken place at Ottawa, on March 6th last, of Mr. Arthur T. St. Laurent, chief engineer of the Canadian Department of Public Works and President of the Engineering Institute of Canada. Mr. St. Laurent was born in Rimouski, Que., in 1859, and graduated as a civil engineer at l'Ecole Polytechnique, Montreal, in 1885. He became connected with the engineering branch of the Public Works Department, and in 1890 was appointed assistant resident engineer at Winnipeg for Manitoba and the North-West. In that capacity he did important work in connection with hydrographic surveys, river improvements and bridge construction. Mr. St. Laurent was the first engineer to introduce the use of cement in bridge-building in Western Canada, and at the time he did so it was regarded as being a very doubtful experiment. In 1895 he was appointed assistant engineer in the department, and after holding other responsible positions, received the appointment of chief engineer last year.

Mr. St. Laurent was greatly interested in the Engineering Institute of Canada, the presidency of which he occupied at the time of his death, having previously served three terms as vice-president. He was also a member of the American Society of Civil Engineers and of the International Congress of Navigation.

BOOKS RECEIVED.

Seaborne Trade. Vol. II. By C. E. Fayle. London: John Murray, 50A, Albemarle-street, W. 1. Price 21s. net.

Railroad Construction. By W. Loring Webb. London: Chapman and Hall, Limited, 11, Henrietta-street, W.C. 2. Price 30s. net.

The Advertiser's A.B.C. Thirty-seventh annual issue. London: T. B. Browne, Limited, 163, Queen Victoria-street, E.C. 4.

The Destructive Distillation of Wood. By H. M. Bunbury. London: Benn Brothers, Limited, 8, Bouverie-street, E.C. 4. Price 35s. net.

Interdépendance. By R. Hofmann. London: Légation de Suisse en Grande-Bretagne, 32, Queen Anne-street, Cavendish-square, W. 1.

A 130,000-Kilowatt Power Station. By G. Klingenberg. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 21s. net.

"The Electrician" Electrical Trades Directory and Handbook, 1923. London: Benn Brothers, Limited, 8, Bouverie-street, E.C. 4. Price 25s. net.

The Industrial Court: Practice and Procedure. By Sir William Mackenzie. London: Butterworth and Co., Bell-yard, Temple Bar, W.C. 2. Price 2s. 6d. net.

The Workmen's Compensation Act, 1906. Twenty-first edition. By W. Addington Willis. London: Butterworth and Co., Bell-yard, Temple Bar W.C. 2. Price 15s. net.

A Text Book of Heat Engines. By Professor Jamieson and E. S. Andrews. London: Charles Griffin and Co., Limited, Exeter-street, Strand, W.C. 2. Price 8s. 6d. net.

The Third Winter of Unemployment. Report of an inquiry. London: P. S. King and Son, Limited, Orchard House, 2 and 4, Great Smith-street, S.W. 1. Price 6s. net.

The Flow of Gases in Furnaces. By W. E. Groume-Grjimailo. London: Chapman and Hall, Limited, 11, Henrietta-street, Covent Garden, W.C. 2. Price 27s. 6d. net.

Institution of Naval Architects.

No. IV.*

The first paper to be taken on the morning of Friday, the 23rd ult., was that by Professor T. P. Abell on "The Behaviour of Stiffened Thin Plating Under Water Pressure." We briefly summarise this paper below:—

STIFFENED THIN PLATING UNDER WATER PRESSURE.

This paper described the test apparatus, and gave some preliminary results of a series of experiments which have been made in order to determine the behaviour of a ship's plate locally reinforced by a stiffener and subjected to water pressure. In designing the apparatus an endeavour was made to represent an actual panel of plating defined by two consecutive frames and, say, the centre girder and adjoining side girder in so far as it is affected by normal fluid pressure only. The size of plate chosen was 8ft. by 2ft. in the clear and the thickness of the plate, which was of ordinary ship's quality, was about 0.40in. The apparatus consisted of two such plates separated by a machined casting 6in. in thickness, the structure, when bolted together, forming a hollow box. Cover plates $\frac{3}{4}$in. in thickness were fitted round the periphery and secured by two rows of bolts. The outer row was $\frac{3}{4}$in. fitted bolts, while the inner row was 1in. tap bolts, with the plain part of the shank turned down so that they did not constrain the plate against end tension in its plane. The plates were thus securely anchored by the outer bolts and clamped by the inner bolts; this condition was considered to approximate more closely to the condition of a plate in a ship. Stiffeners were fixed on the inner side of the plate and were secured with fitted bolts. The pressure was applied by means of an ordinary boiler testing pump operated by hand and a stand pipe, which could be carried to a height of 70ft., was used. The deflections were measured from a heavy stiff cast iron bridge supported at three points, and dial micrometers reading to 0.0001in. were used. The results given include figures and curves of deflection for a plate fitted with a single central stiffener, for a load corresponding to a head of 25ft., and a plate fitted with three stiffeners loaded corresponding to a head of 47ft. A dimensional drawing of the apparatus is given, and the results obtained are briefly discussed from the point of view of their application to shipbuilding problems.

Sir Westcott Abell said that the author was to be congratulated on being the first to deal with this problem experimentally. It was difficult work calling for the measurement of very small quantities and the determination of the first and second differentials for small quantities. He noted that the author stated he had been led to the uniform procedure of determining the curve of deformation at the uniform distance from the edge of the cover plate, but it would be more desirable to know the curve of deformation, not at a uniform but at a varying distance from the edge of the cover plate.

Mr. J. Foster King said it would be of value if it were possible to deduce from the experiments what were the facts as far as they related to stress and load. It would appear that under certain conditions of loading the stress upon the edge of the plate would be of the order of 16 tons, and yet the author found no evidence of permanent set, although one could hardly think that would be the behaviour of ordinary commercial steel. It was satisfactory to learn that the author was satisfied that under the conditions named the moment of inertia of the stiffener was a measure of the efficiency of the stiffener. His deduction from the experiments was that they must deal with the capacity of the plate to resist a load as one item, and the capacity of the stiffener as a separate item. There could be no question of the value of the work to the practical constructor.

Professor J. J. Welch agreed that the method of securing the edges employed gave a close approximation to the conditions of continuous plating. The most interesting part of the paper was, of course, the results given of deformation and more particularly the results of the stresses. The conclusions given in page 8 of the paper that "free ended stiffeners suitably designed can be used to reinforce a thin plate in a manner which will avoid concentration of stress and effect a substantial general reduction of stress," was a testimony to the soundness of the method adopted for many years past in stiffening the thin plates of bulkheads in upper 'tween decks.

Dr. Laws—in a contribution to the discussion which he will amplify in writing—said that while the field which had been explored was not large, it represented a vast amount of work and the practical elimination of vacations over a long period. He had been associated in a small way with the initial stages of the inquiry. He had also done some similar work himself, and having regard to the fact that the paper did not record the nature of the stress away from the edge of the cover plate, it might be of interest to state that in exploring the area between the cover plate and the end bolt of the stiffener, he found a gradual increase in stress approaching the bolt which reached a maximum between the edge of the cover plate and the centre of the bolt. This stress was local, but its maximum value was of the order of 20 per cent. in excess of the maximum stress for an unstiffened plate and must be taken into account. Upon the nature of the greater stress produced in the plating in the neighbourhood of the end of the stiffener hung the value of the experiments as far as application to practical construction was concerned. That a favourable distribution of stress could take place was indisputable, and that with this the maximum stress could be reduced by multiplying the stiffeners was evident from the results recorded in the paper. The obvious question was whether a satisfactory condition of stress could be brought about by introducing stiffening bars of such a number and

* No. III. appeared April 6th.

size as to be economical. That was the point in which the practical shipbuilder was interested. He believed that at least in those cases where the distance between the longer sides of the rectangle was not abnormal and the load on the plate area was not excessive, the method of stiffening suggested was satisfactory and might result at certain parts of a vessel in reducing weight while the strength of the structure was preserved. In the case of vessels of more than normal dimensions, where the load might be excessive and where the dimensions of the rectangle area tended to increase, it might not perhaps be worth while to adopt this particular form of construction. That was one of the problems which remained to be solved, and called for a further series of experiments.

Mr. Bailey said that Professor Abell gave the stress at the edge of the plate with the single stiffener, and it was to be inferred that it was deduced by obtaining the principal curvatures of the plate at the edge. If that were so it would seem that the stress so obtained could not be the actual stress, since the method adopted did not take into account the way in which the clamping supplied the component forces near the edge. If the stiffener was attached to the plate by more than one bolt there must be shearing forces coming into play, and these tended to make the stiffener and a portion of the plate behave as one homogeneous beam, the stresses in which could not be determined by measuring the curvatures of the plate. Professor Abell stated that the stress in the plate at the end of the stiffener would be higher if the stiffener had been kept of the same cross section throughout, and he would like to know his reason for making that statement if he had not tested its experimentally. It had been Admiralty practice during a recent period in the case of stiffeners to water-tight girders and frames between the outer and inner bottom of a ship to extend the stiffener over the flanges of the angles connecting the girder to the bottoms. This had been done with the object of preventing high stress in the small portion of plating which would otherwise be left unsupported, and of preventing the bending action which would come on the rivet head. The case was not quite parallel to that which was the subject of Professor Abell's experiments, but it would be of interest if he could give attention to this point. There was another aspect of the problem on which the opinion of the author would be very welcome. In estimating the maximum stress in the bottom plating of a ship due to the ship as a whole acting as a girder, to what extent were designers justified in accepting a stress above the elastic limit of the material? Were the general scantlings of a ship to be determined to limit the stresses on small zones, or could the shipbuilder allow a small amount of local permanent set? In effect, could the designer ignore stresses in the bottom plating due to local water pressure and stiffen the plating solely with a view to keeping the deflection within limits.

Professor Abell, in reply, said it was extremely difficult to find out what the boundary conditions were at the edge of the plate. It was not possible to get absolute contact between the plate and the cover plate the whole way along, and equally impossible to find the contours of contact. With regard to the deformation of the cover plate itself, the figure was small even under extreme conditions, being of the order of $^3/_{1000}$in. That the plate itself did deform was beyond doubt. He did not think that there was any concentration of stress at the end of the stiffener. Mr. Foster King had suggested that it was possible to separate the plate from the stiffener, but he was unable to go that length.

A paper on "Further Experiments on Large Riveted Joints" was then read by Mr. J. Montgomerie. We give below a *résumé* of it.

EXPERIMENTS ON LARGE SIZE RIVETED JOINTS.

From 1917 to 1920 the author undertook on behalf of the Committee of Lloyd's Register of Shipping an experimental research on the elastic properties of riveted overlap joints such as are used in ordinary shipbuilding. These experiments, the results of which have already been published by the Committee, were made on twelve plates, six of which were 0.44in. in thickness, connected by treble-riveted overlaps, and six of 0.58in. in thickness, connected by quadruple-riveted overlaps. Following a suggestion made by Viscount Pirrie, it was decided to continue these experiments with larger rivets and correspondingly thicker plates. A series of seventeen specimen joints were prepared by Harland and Wolff, Limited, and tested at the Glasgow Proving House. Twelve quadruple-riveted joints were prepared, six of these being formed between plates of dimensions 13in. by 1.04in., the joint containing twelve rivets 1¼in. in diameter. The remaining six were formed between plates of dimensions 19½in. by 0.75in., the joint containing twenty rivets 1in. in diameter. In addition to the above, five other joints were prepared, formed between plates of dimensions 17in. by 0.58in. Two of these were treble riveted, one having a uniform spacing and the other having the rivets in the outside rows more widely spaced than those in the central row. The remaining three joints were treble, double, and single riveted respectively, with the object of obtaining some relation between the point at which "slip" occurred and the actual number of rivets employed. The joints were made up with both iron and steel rivets and hand, pneumatic and hydraulic riveting was employed. The paper deals with the results of these experiments and is accompanied by tables and curves and drawings of the actual joints. The following are stated as the results derived from the two combined researches:—

(1) The assumptions underlying the theory on which the design of riveted joints rests are not valid, *i.e.*, the load is not distributed impartially among the rivets, and a state of uniform stress exists nowhere in the joint.

(2) For pulls up to the point at which slip takes place the maximum stress occurs in each plate on that surface next the edge of the joint. At this point the stress is nearly double the stress in the normal plate. On the opposite surface the material is practically relieved of stress. The average stress across the section of the plate at this point is therefore approximately the same as that found in the normal plate.

(3) For plates up to 0.60in. in thickness slip takes place in the joint when the pull applied, distributed over the area of the rivets, produces a stress figure of from 7.5 to 8.0 tons per square inch. For plates 0.75in. thick the pull producing slip when referred to the area of the rivets gives a stress figure of approximately 6.2 tons per square inch; and in plates 1in. thick this figure is approximately 5 tons per square inch. Up to that point the joint behaves as an elastic solid; but the elastic qualities of this solid are much more marked in the cases of the thinner plates, and they diminish rapidly as the thickness of the plating is increased.

(4) The pull producing slip when referred to the sectional area of the normal plate corresponds with a mean stress of 9.0 tons per square inch in the case of plates from 0.40in. to 0.60in. in thickness, to 6.6 tons per square inch in plates 0.75in. thick, and to 4.3 tons in plates 1in. in thickness.

(5) For the 1in. plates, as re-riveted with special precaution adopted to secure effective contact between the surfaces, slip takes place in the joint when the pull applied, distributed over the area of the rivets, produces a stress figure of 7 tons per square inch, taking the higher value, and 6.5 tons per square inch with the lower; when referred to the area of unpierced plate, the stress figures produced are 6.1 and 5.7 tons per square inch respectively.

(6) For the thinner plates no appreciable distinction can be drawn in regard to the elastic qualities or ultimate strength of the joint in respect of the method of riveting adopted or the rivet material used. With the thicker plates, however, a material difference is revealed, the hydraulic riveting yielding the best results.

(7) The average strain over the whole joint does not materially differ from that found in the surrounding material, except in the case of the 1in. plating, where the average strain over the joint is considerably more than that found in the plating. The only two exceptions are two hydraulically re-riveted joints, which at moderate stresses give favourable results.

(8) In a lapped joint the outer rows of rivets are more severely stressed than the inner rows.

(9) By adopting precautions for securing ultimate contact between the surfaces of the plates as described in the text, it is possible materially to raise the slip point for thick plates and rivets of large diameter.

The paper is accompanied by an appendix giving a chronologically arranged bibliography of the literature on riveted joints.

Mr. C. E. Stromeyer referred to the value of the experiments in confirming ideas which had long been entertained in connection with the strength of plates. The experiments on the difficult question of slip were particularly valuable.

Sir Westcott Abell, who said he had been associated with the author in the work described in the paper, expressed his interest in results obtained with thick plates. The work done should have the effect of extending knowledge of what might happen under working conditions as against ultimate strength experiments. The author's earlier experiments on the question of slip would be recalled. The most striking feature of the results was the marked falling off in the values at which slip occurred when the thickness of the plate exceeded a certain limit. It was only fair to state, however, that joints of thicknesses of which experience was available had in practice fulfilled all the demands made upon them. One important point which emerged from the work was that in thick plates it was necessary to use hydraulic riveting. Dr. Montgomerie showed, too, that there was a substantial increase in the value of the joint when care was exercised in fitting, and it was possible to get an increased adhesion of 30 per cent. in a 1in. plate. The author deserved congratulations for his bibliography.

Mr. Foster King said that they were grateful to Lloyd's Register for publishing this important information for the general benefit. He might perhaps be allowed to express the hope that too much theoretical importance would not be attached to the work and an endeavour made to build a theory upon it. The great thing driven home by the experiment was the need of a good fit or, what Sir Archibald Denny had long since called, good "stiction." It was clear that the older generation of shipbuilders were not so far wrong in adopting duplicate straps and attachments of that order in the case of heavy plates. It was possible that an increase of the diameter of the rivet in proportion to the thickness of the plate would give the increase of adhesion which was desired to attain uniformity throughout the whole range.

Dr. Montgomerie, in closing the discussion, said that the actual breaking strength of joints had been determined hundreds of times; what the ship designer and shipbuilder desired to know was how that joint would behave under stress when it was incorporated in the structure of a steel ship. It was true there had been no great marine disasters caused by the splitting asunder of joints in heavy plates, but that proved nothing. After studying this subject he had had impressed upon his mind the fact that their predecessors in the art of shipbuilding had made enormous contributions to this practical art. It was a remarkable fact that without any accurate knowledge of stress distribution they should have been able to devise riveted attachments which had remained practically unaltered down to the present day.

The first paper taken at the afternoon session was that on "The Influence of Form upon the Stability and Propulsion of Passenger Ships," which was presented by the author, Mr. John Anderson.

FORM AS INFLUENCING STABILITY AND PROPULSION IN PASSENGER SHIPS.

Recent developments in the building of passenger ships have been in the direction of increased superstructure and freeboard, extra deck equipment, redisposition of structural material and the adoption of forms which are beneficial for propulsion but detrimental to stability. The effect of increased breadth has been nullified by extension to top-side arrangements, and the question has arisen as to what is the minimum amount of metacentric height for a vessel in the sea-going condition. As a result of observations taken during various sea conditions, the author suggested that the following, though in some respects an indefensible formula, might be used as a quantitative index of the minimum amount of metacentric height necessary—

$$G M = \frac{0.70}{b} \times \frac{R}{A}$$

—where b is the block coefficient, R is the longitudinal area above the water line, and A the longitudinal area below the water line. Tables and designs were given for vessels of different types under varying conditions of loading, and the G M given by the proposed formula stated. The advantages conferred by deep tanks were also discussed. A modified form with a slight bulge was proposed, and comparative figures were given for vessels of 6450 tons cargo deadweight and 15 knots speed with the original form, with increased beam, and with the proposed new form. It was suggested that such a form would be advantageous to the owner in shifting a vessel when light and also to builders, considering that it was necessary to have considerable stiffness when fitting out and that during construction the ordinary ballast tanks were not always available for this purpose.

Professor P. Hillhouse said the formula which the author suggested deserved consideration. One great advantage was that his method was very easy to apply. It had to be borne in mind that as ships got larger the proportion of length to breadth steadily increased. He would remind the meeting that bulges were fitted to the German ship Cap Polonia to improve the metacentric conditions, and bulges had also been fitted to the vessels Deutschland and Albert Ballin. The same practice had been followed in the case of the Empress of Britain, and although the bulges added a little to the resistance of the ship, this was not a serious factor.

Sir Westcott Abell said that the paper clearly revealed the complexity of the problem dealt with. There were three main points:—(1) That it was very desirable to obtain a geometrical standard which would give a proper metacentric height for sea-going conditions; (2) it was also desirable to have a standard metacentric height for the vessel in the light condition; and (3) as designers had been in the habit of obtaining the sea-going conditions by a sacrifice of the metacentric height in the light condition, the question arose whether it would not be possible by a modification of transverse form to improve the initial stability in the light condition without recourse to the use of water ballast. Mr. Anderson had confined his work rather to the statical side of the problem, but it appeared necessary to take some account of dynamical conditions. It has been suggested that in order to obtain dynamical measure of stability conditions a standard wind pressure of 25 lb. per square foot should be assumed for the above-water portion and a standard upsetting couple assumed, based on this pressure multiplied by the distance between the centre of gravity of the above-water area and the mean draught. If that point of view were correct, Mr. Anderson's standard formula would require to be amended by the introduction of a term indicating the ratio of depth to breadth. While on the subject of dynamical conditions, he would again draw attention to the advantages of studying stability problems by an investigation of sea conditions. This could be arranged by co-operation between shipowners, shipbuilders, and naval architects, and indeed some progress in this direction had been made. The difficulties of initial stability in the light condition were generally realised, and where vessels began to be limited in proportion on account of docking facilities it was necessary to adopt some modification of form to obtain the necessary stability. Disregarding the question of docking limitations, he noted that Mr. Anderson claimed as an additional advantage that the modification of form would reduce resistance and the weight of hull. The saving of weight appeared to be achieved by reduction of deck area. He would also point out that in making the calculations Mr. Anderson had not obtained, or at least had not disclosed, what would be the effect of the modification of form on the statical stability curve or on the dynamical stability. It seemed clear that further investigation was necessary.

Professor J. J. Welch was not altogether convinced that a case had been established for a change of metacentric height, and said experience had shown that good results from the stability standpoint could be obtained on a sea-going vessel of large metacentric height.

Mr. A. P. Wall agreed that good results had been achieved in vessels with large metacentric heights, but there were, of course, other factors which affected stability. In one instance he had in mind the ship was 350ft. long, of 10ft. draught, and had a metacentric height of 3ft. 9in., but was a good sea-going vessel. Mr. Anderson appeared to have established the fact that his formula would enable a reduction of horse-power to be brought about with a consequent reduction of cost, but had not so clearly established his argument on the subject of stability.

Mr. Anderson, in replying to some of the points raised, said that, having regard to the keen competition in the shipping industry, it was necessary to cheapen the cost of obtaining stability conditions, and the cheapest way appeared to be the fitting of a bulge.

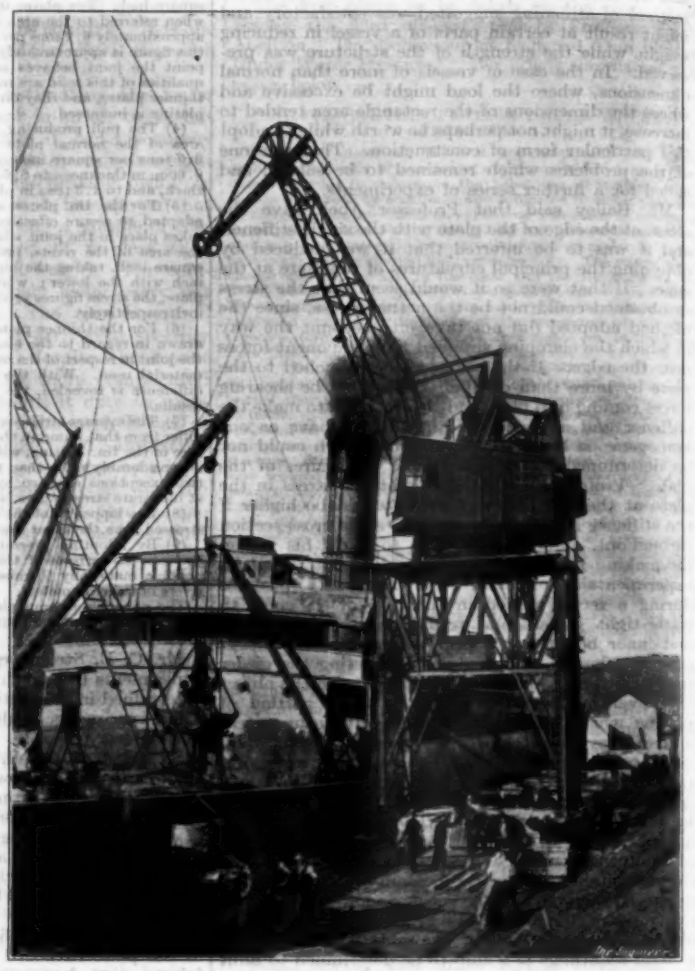
The next paper taken was that by Mr. W. Thomson, "The Effect of Variations in Loading on Longitudinal Structural Stresses in Ships." The following is a short *précis* of this paper.

THE EFFECT OF VARIATIONS IN LOADING.

The principal object of this paper was to draw attention to the results which may follow a departure from the standard

PORTAL JIB CRANES ON THE WHARF OF RISDON ZINC WORKS, TASMANIA

BABCOCK AND WILCOX, LIMITED, LONDON, ENGINEERS



conditions of loading. As an example, an ordinary cargo carrier of 10,000-tons cargo capacity, having dimensions 430ft. by 56.75ft. by 33ft. and a load draught of 25ft., was taken. Tables and curves were given showing the bending moments and shearing forces for such a vessel, both in the hogging and sagging condition, with the machinery placed alternatively amidships and aft and when carrying homogeneous and ore cargoes. The case of a cargo vessel in ballast condition was also worked out, and similar particulars were given for oil-carrying vessels, both in loaded and ballast conditions. As an extreme example, a 400ft. oil tanker, with three tanks empty, was cited, and it was shown that whereas in the standard condition the compression on the deck plating was 7.5 tons per square inch, it was possible to vary this figure from 4.8 to 10.6 tons by having the empty tanks amidships or at the ends. In general it was stated that the structure of vessels as usually built would fulfil satisfactorily the demands made upon them provided the distribution of the cargo did not depart in too great a degree from the assumed standard; but in order to secure the best results, the naval architect should have the co-operation of those who had the handling of the vessel after completion so that extreme conditions of all kinds could be avoided. This was truer to-day than in the past, as modern vessels were designed upon scientific considerations, which, in view of the increased efficiency in the disposition of the material, permits the utilisation of less weight of material in the structure itself.

Mr. J. Foster King said that the question of sagging stresses became every year of greater importance, and the presentation of this paper reflected the interest of Lloyd's Register in the subject. Old ideas had been upset by the complete change in design and arrangement which had taken place in ships as much as, if not more than, in the disposition of the cargo. A new responsibility rested on the shipowner, who was not justified in taking so much for granted as in past years. The naval architects had improved the structural side of the modern ship, and it might be said that by as much as the design had been improved the shipowner had abused it.

Sir Westcott Abell said that although the subject of structural stresses experienced by ships in a seaway had often been dealt with, Mr. Thomson had presented a series of comparative results which were worthy of careful study by all concerned either in the building or the maintenance of ships. The paper brought out quite clearly the dangers of improper loading. So far as oil vessels were concerned, one of the most striking features brought out was the large difference in bending moment resulting from a comparatively small rearrangement of the cargo. The condition with all the cargo concentrated amidships was one which, although not actually unknown, was not likely to recur; but even excluding that case, there were other conditions indicated which must be avoided. It was not desirable perhaps to found too much on purely longitudinal conditions, since local concentration of stress must be taken into account, and, on the whole, he was inclined to think that what was needed was elasticity in the distribution of the cargo in the form of the provision of a large number of small tanks. The figures given for cargo vessels did not call for comment, except where the machinery was fitted aft. It was not always realised that the sagging moment in that case was of considerable magnitude and called for careful consideration of the scantlings of the topside material to provide against compressive stresses. That feature also appeared in the vessel with machinery fitted amidships when deep tanks of large capacity were fitted. The author's calculated stresses for vessels of different lengths were, he thought, too high. In the paper which he (Sir Westcott Abell) brought before the Institution some years ago on the work of the Loadline Committee he gave an approximate formula $5\ (1 + L/1000)$ tons per square inch as representing the tensile stress on the deck in ordinary cargo vessels, and possibly the author could give the reason for the higher figures he had obtained.

The last paper on the agenda was that by Mr. E. V. Telfer, "Graphical Trim Calculation and a Trim Nomogram."

GRAPHICAL TRIM CALCULATION AND A TRIM NOMOGRAM.

Dealing with the graphical method of trim calculation known as Long's trim-curves, the geometry of trim curves, the usual presentation and practical manipulation of these curves was examined. Results worked out for an intermediate passenger vessel of 400ft. length by 55ft. breadth and 24ft. draught, with an 0.668 block coefficient expressed in the form of a trim nomogram. The author referred to the simplicity of the nomographic treatment of the problem, and expressed the hope that the trim nomogram would be adopted for ordinary drawing-office purposes and also for presentation to ship's captains.

In opening the discussion, Professor Hillhouse referred to the work which would have to be done in preparing such a diagram for each particular case. The captains of ships were keen indeed to have accurate information as to the altering of weights in order to get better trim. He had found that a simple capacity plan based on the average service draught and showing at a glance the effect of filling or emptying of any given compartment was very satisfactory in practice. This method was not, of course, extremely accurate and did not take into account all the conditions.

Professor Welch agreed with the previous speaker that the information given to ships' captains should be simple and easy of application. He regarded the accuracy of the nomographic method as all to the good.

Mr. G. S. Baker said the paper reflected the excellent results of the scholarships of the Institution which were available to students.

Mr. Dana, the secretary of the Institution, in acknowledging a vote of thanks to the staff, said that the scholarships which had been placed at the disposal of students owing to the public spirit of a number of firms were not taken advantage of to anything like the full extent. There were thousands of apprentices of naval architects and marine engineers, and he thought there ought to be more than twenty or thirty out of that number competing for scholarships worth £150 a year for three years.

Mechanical Handling Equipment at a Tasmanian Zinc Works.

In spite of the dislocation of the world's activities caused by the War, the development of Australian resources has steadily proceeded during the last decade. Of the various noteworthy enterprises which have been undertaken within that period, one of the most successful is that of the Electrolytic Zinc Company of Australasia. Prior to 1914, the bulk of the zinc-bearing concentrate produced at Broken Hill, New South Wales, was sold in Europe to be there treated for the recovery of its zinc contents. The method in vogue was that of distillation whereby the ordinary spelter of commerce was produced. Great improvements in the treatment methods have taken place, and since November, 1921, the Electrolytic Zinc Company of Australasia, Limited, has produced zinc of excellent quality on a large scale in Tasmania by the electrolytic process, and is now using electrical energy at the rate of 30,000 horse-power continuously in the production of that metal.

A brief account of the process carried out at the Risdon Works of the company has already appeared—see The Engineer, September 22nd, 1922—and the electrical equipment required for the plant has been described in some detail. The site of the works, which is on the Derwent Estuary in Tasmania, is some 900 miles by sea rom the nearest South Australian port from which zinc concentrates can be shipped, and Broken Hill itself is 250 miles inland from the South Australian seaboard. The Derwent Estuary is a huge land-locked stretch of deep water which forms one of the finest natural harbours in the world. Risdon itself is approximately 12 miles from the entrance, and at the company's wharf a depth of from 30ft. to 40ft. of water is available at all states of the tide, which has a normal rise and fall of only about 4ft. The largest overseas vessels can thus directly ship the metal produced and intermediate handling between works and port is unnecessary.

The wharf is 800ft. long and 60ft. wide, built parallel to the shore, with which it is connected by two short jetties, each 60ft. wide. The hardwood decking, which is 10ft. above the mean water line, is carried on Tasmanian hardwood piles placed at 10ft. centres. Time and cost of handling have been reduced to a minimum by modern equipment of electric locomotive cranes and conveyers installed on the wharf. The two cranes are of the portal jib type, and were built by Babcock and Wilcox, Limited. They are similar in general design to those which were

supplied by the makers to the Port of London authorities. Each crane is fitted with the firm's patented self-dumping grabs, which were manufactured by Messrs. Priestman Brothers under licence. The hoisting motion is operated by an 85 brake horse-power motor, which is designed to lift a maximum load of 7 tons at the rate of 120ft. per minute. A solenoid brake fitted with a hand release controls the load, and there is, in addition, a second brake operated by a foot pedal. A centrifugal brake on the motor extension shaft comes into operation when the speed of the motor reaches about 750 revolutions per minute. The grab is opened by resting. A special feature of the crane is the jib, which is of the self-balancing type and, in consequence, requires merely a 5 horse-power motor to luff it and the load at 200ft. per minute. The same power is sufficient when running either in or out, and this condition is unaffected by the load on the end of the jib. The motor is fitted with a solenoid brake and an over-winding switch, which comes into operation at maximum and minimum radius.

The jib commands a radius of 50ft., and the crane can slew through a complete circle in 40 seconds. Slewing is effected by a 15 horse-power motor working through three reductions of gear to a pinion which engages in a pin rack pathway on the top of the carriage. A foot brake is provided to control the motion. From the driver's cab, which is 34ft. above the wharf deck, the operator has a clear view of the wharf and the hatchway. The carriage rests upon sixteen wheels, and its weight is distributed equally over the wheels by a series of equalising beams. Travelling along the wharf at the rate of 50ft. per minute is effected by means of a 15 horse-power motor. Control of the whole machine is simple and flexible. The load may be retarded or stopped in its descent with ease, and all four motions of the crane may be checked immediately in case of emergency by the pressing of one button.

The necessary electric power for the operation of the cranes is supplied at 415 volts from lines carried underneath the wharf, and the flexible cable connecting with the crane is carried on a balanced pulley system on the side which reduces the risk of accidental injury to a minimum.

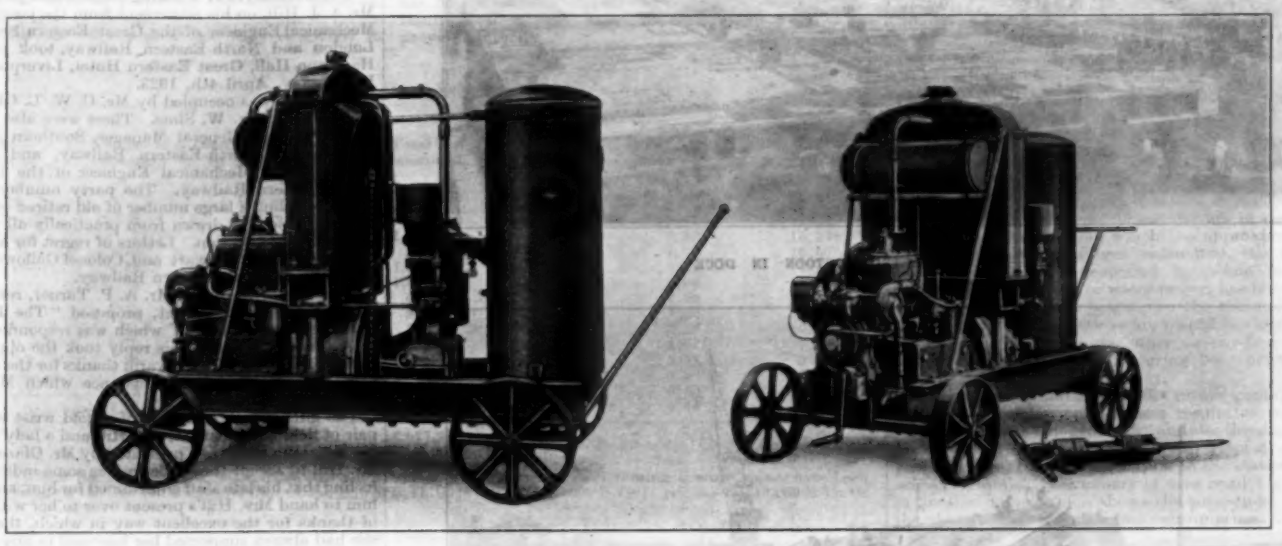
The calcine which is handled by these cranes is a fine granular substance and, in fact, is flotation zinc concentrate which has been thrown to waste on the mainland. It is unloaded into two movable hoppers standing astride a horizontal belt conveyor which is itself placed centrally on the wharf. These hoppers are carried on rails, and the position of each may be readily adjusted in accordance with the ship's hatches. Each hopper carries a grid of stout hardwood beams which supports the weight of the grab when discharging. The V-bottom of the hopper is fitted with a rotating roller feed and balanced gates, between which the calcine is forced at a uniform rate to the conveyor belt. While there is thus a positive steady discharge of the fine ore, occasional lumps of calcine are permitted to pass without choking the exit or damaging the roller. A 5 horse-power motor is provided to operate the roller.

The troughed rubber belt conveyor is 24in. wide, and the length between centres of pulleys is 293ft. The upper portion is 9ft. above the decking, and the belt is driven by one 25 horse-power motor. It discharges its load to a second troughed conveyor 320ft. long operating at right angles to the first and rising at a slope of 1 in 6 to the head of a large storage bin. One 40 horse-power motor is required to drive this belt. Both conveyors are protected by galvanised iron screens to avoid dusting losses during transit. The cranes and belt conveyor system can unload and store calcine at the rate of 300 tons per hour.

The calcine storage bin, which has a capacity of 20,000 tons, has a concrete floor 200ft. long by 80ft. wide and to a height of 11ft. it is provided with stoutly buttressed concrete sides, which take the outward thrust of the contents of the building. The superstructure above these concrete walls consists of steel framing and galvanised iron. A horizontal belt conveyor operating in the building at a height of 42ft. distributes the incoming material over the floor. From the storage the calcine is moved into trucks by means of a Thew electric shovel and portable conveyor, which can move 60 tons of ore per hour.

The up-stream portion of the wharf is reserved for the accommodation of two products of the works, slab zinc and silver-lead residues. The former consists of ¼ cwt. slabs of metal which, produced at the rate of upwards of 5000 per day, are conveyed down hill to the wharf from the casting division by means of a link conveyor 520ft. long. The slabs are there weighed, stencilled and trucked. A small travelling gantry is provided on the wharf itself, and by means of this stacker slabs are removed from the trucks and placed in position ready for shipment. The stacker carries a special frame for lifting stacks of sixty slabs slung from a run-way 28ft. long, which is carried by the gantry at a height of 12ft. 6in. above the decking of the wharf.

The silver-lead residue is the undissolved portion of the original calcined ore. It is trucked to the wharf and shipped, as return freight, to the works of the Broken Hill Associated Smelters Proprietary, Limited, at Port Pirie, South Australia, where the lead and silver in it are recovered by smelting. Both the zinc and residue are loaded into shipping by means of the cranes, views of which are given herewith and on page 394. The wharf and its equipment are the property of the Electrolytic Zinc Company of Australasia, Limited, and have been constructed by the company solely for its own use. The tonnages to be handled annually are about 150,000 tons of calcine, 40,000 to 50,000 tons of zinc, 35,000 tons of lead-silver residues, and a large amount of coal and stores of all kinds for use in operating and constructional work.



LACY-HULBERT PORTABLE SELF-CONTAINED AIR-COMPRESSOR

A Self-contained Portable Air Compressor.

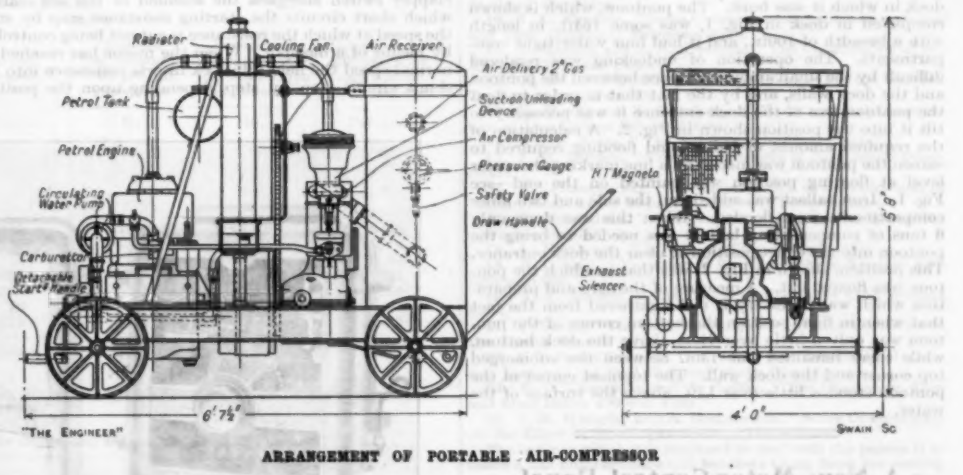
For use especially for steel construction, road-breaking and contractors' work generally, a new type of self-contained portable air compressor has recently been put upon the market by Lacy-Hulbert and Co., Ltd., of Beddington, Croydon. It is illustrated by the accompanying engravings. The particular object which the firm had in view in designing this new type of plant was to avoid troubles, experienced in the past, which have been due to overheating, over-lubrication, over-loading, &c. In consequence, we understand that a larger engine than is absolutely necessary to drive the compressor has been fitted; that the radiator and receiver are both of them of more than the required size; that ball or roller bearings are used everywhere; and that every part of the plant has been made specially strong.

The compressor, which is single-acting and which the makers designate their LV1 type, is designed to deliver from 50 to 60 cubic feet of free air per minute compressed to 100 lb. per square inch when running at speeds varying from 900 to 1200 revolutions per minute, but it is intended to work up to 120 lb. per square inch if desired. The piston is made of an aluminium alloy, while the connecting-rod, which is fitted with ball bearings at the big end and with roller bearings at the gudgeon pin end, is of steel. The crank shaft with its balance weight is a one-piece steel forging, and is carried in roller bearings. The crank case is in halves, the upper part being cast solid with the cylinder. The cylinder is water-jacketed, and there are water passages round the valves in the cylinder cover. The valves themselves are of the firm's standard spring-controlled disc type. In addition to the automatic inlet valve fitted in the cylinder cover, air is also admitted by a port from the crank case at the bottom of the piston stroke and at a pressure slightly above that of the atmosphere, by which device it is claimed that high volumetric efficiency is obtained in the cylinder. The compressor is fitted with Messrs. Lacy-Hulbert's standard automatic unloading valve, the inlet to which serves as a silencer, which, it is stated, effectively reduces the noise usually present at the suction inlet.

The engine which drives the compressor through a flexible coupling, is made by Dorman and Co., Limited, of Stafford, and has two cylinders. It runs on petrol, is designed to develop 20 horse-power at 1000 revolutions per minute, and is fitted with a circulating water pump, an oil pump, and a high-tension magneto. This engine, as has been already said, is larger and more powerful than is absolutely necessary, to the extent, so we gather, of no less than 30 per cent., with a view of ensuring an ample reserve of power and also of obviating risk of fatiguing of the engine by long continuous work at full output of the compressor. The cooling water is circulated by the pump on the engine, from the bottom of the radiator —which, besides being of full size itself, has also a large fan—through the jackets of both engine and compressor. The latter is lubricated by means of a pipe from the engine lubricating oil pressure service, the delivery being adjustable, so that it is possible to avoid superfluous oil being carried over with the compressed air.

The plant in standard practice is mounted on a steel frame furnished with four travelling wheels, two of which are made to swivel and are furnished with a draw handle, but it can also be supplied mounted on a neat-looking trailer truck furnished with rubber-tired wheels. This trailer, the makers explain, enables the machine to be taken to jobs very quickly and to be taken home at night, thus rendering it unnecessary to employ a watchman. The machine is complete with petrol tank, engine silencer, receiver fitted with a pressure gauge and a "Pop" safety valve, tools, spares, &c. The overall dimensions are 6ft. 7in. long by 5ft. 8in. high and 4ft. wide, while the weights are 21 cwt. net and 28 cwt. gross, and the shipping measurement 200 cubic feet. Each plant can, the makers inform us, drive the following tools:—Three or four riveting or chipping hammers; or two or three drilling machines; or one or two rock drills; or two road breakers; or two or three pneumatic picks or shovels.

In full operation, the cost of oil—fuel and lubrication—is given as being 2s. per hour. The plant can be mounted on a Ford 1-ton truck, so that it can be readily transported from place to place, and it can be kept at work on that vehicle without doing damage or setting up excessive vibration.



ARRANGEMENT OF PORTABLE AIR-COMPRESSOR

UNDOCKING A PONTOON FOR A 250-TON FLOATING CRANE

FIG. 1—THE COMPLETED PONTOON IN DOCK

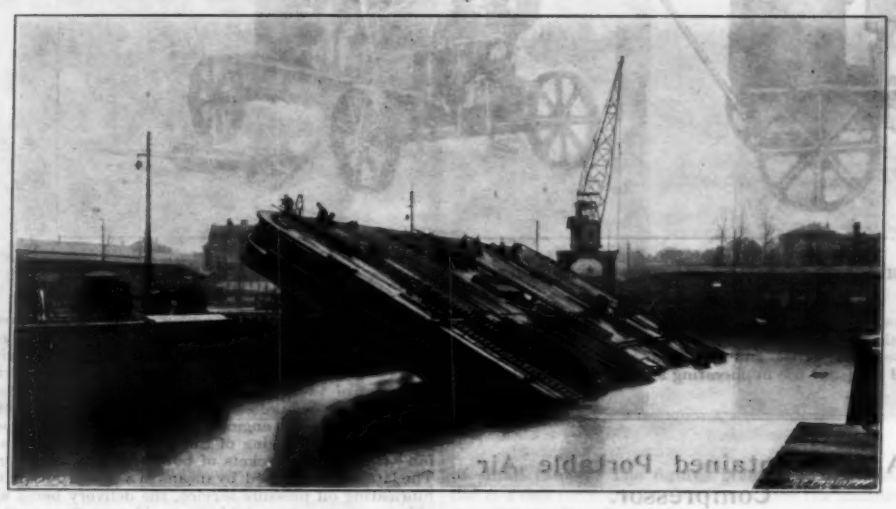


FIG. 2—THE PONTOON CAREENED FOR UNDOCKING

A Novel Undocking Operation.

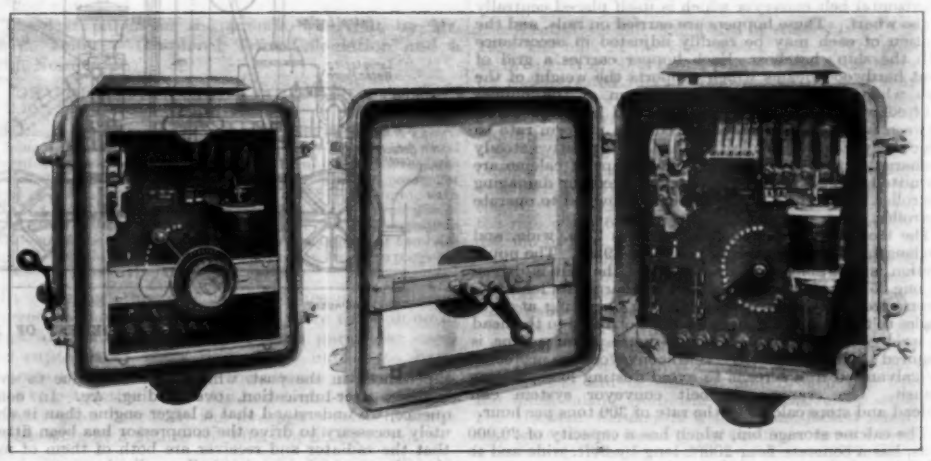
A SOMEWHAT unusual and novel undocking operation was successfully carried out at the yards of the Deutsche Werke, Kiel, early in December, when a large pontoon built for a 250-ton floating crane was floated out of the dock in which it was built. The pontoon, which is shown completed in dock in Fig. 1, was some 164ft. in length with a breadth of 100ft., and it had four water-tight compartments. The operation of undocking was rendered difficult by the small amount of space between the pontoon and the dock walls, and by the fact that in order to float the pontoon free of the dock entrance it was necessary to tilt it into the position shown in Fig. 2. A calculation of the required amount of ballast and flooding required to careen the pontoon was made and a line marking the water level at floating position was painted on the end—see Fig. 1. Iron ballast was added and the side and two inner compartments were flooded. When this was done only 6 tons of compensating ballast was needed to bring the pontoon into the exact position to clear the dock entrance. This position, shown in Fig. 2, was that in which the pontoon was floated out. A measure of the care and preparation which was necessary is to be gathered from the fact that when in final position the bottom corner of the pontoon was only a little over 19in. above the dock bottom, while there remained but 13in. between the submerged top corner and the dock wall. The topmost corner of the pontoon stood a little over 13ft. above the surface of the water.

A New Motor Control Panel.

For the control of electrically driven printing presses and machine tools the Igranic Electric Company, of 147, Queen Victoria-street, has recently introduced a new control panel, which comprises a self-acting starter of the multiple finger type, a single-pole magnetically operated clapper switch, a hand-operated field regulator, a hand-operated double-pole main isolating switch, and an overload trip if specified. The whole of the apparatus, which is shown in Figs. 1 and 2, is enclosed in a substantial ventilated housing composed of cast iron and sheet metal, the lid being glazed. The motor is controlled through the automatic panel, with a two-way start and stop push button, a master switch with a start push button, and a stop trip lever, or a three-way "start," "inch," and "stop" push button. Float switches, diaphragms, pressure regulators, or other devices may be used.

Assuming that the double-pole switch is closed, the application of pressure to the starting button closes the magnetically operated clapper switch which connects the motor to the line through the series resistance, the control circuit of the clapper switch being maintained brought the stop push button. The motor then starts with all the series resistance in circuit and with a fully excited field, the field resistance being short-circuited during the whole of the starting period by means of a patented shunt field interlock. When closed, the main clapper switch energises the solenoid of the self-starter, which short circuits the starting resistance step by step, the speed at which the resistance is cut out being controlled by means of a dashpot. When the motor has reached its normal speed the field interlock inserts resistance into the shunt circuit step by step, depending upon the position of the field regulating lever, the maximum number of steps being four,. It will thus be seen that the speed of the machine may be set by the field regulator, and every time the motor is started it will automatically run up to its predetermined speed without having to make an adjustment after each start. The automatically operated clapper switch is interlocked so that the main circuit is always made and broken by this switch.

On depressing the stop button the control circuit of the clapper switch is opened and the motor is stopped. The solenoid of the self-starter is also de-energised and starting resistance inserted in the circuit ready for the next start. If inching is required separate inching buttons may be used or a combined start and stop and inch three-way push button. The act of pressing the inching button closes the main clapper switch, which connects the motor to the line with all the series resistance in circuit and the main field resistance short-circuited. The solenoid of the self-acting starter is not energised and the clapper switch only remains closed as long as the pressure on the inching button is maintained, and consequently all the time this pressure is on the inching button the motor runs at a low speed. Panels of this type are made for motors up to 10 horse-power working at 110 volts and up to 15 horse-power at 220-500 volts. The approximate overall dimensions are 24in. by 24in. by 16in.



FIGS. 1 AND 2—IGRANIC MOTOR CONTROL PANEL

PRESENTATION TO MR. A. J. HILL.

A COMPLIMENTARY smoking concert and presentation to Mr. A. J. Hill, on his retirement from the position of Chief Mechanical Engineer of the Great Eastern Section of the London and North-Eastern Railway, took place in the Hamilton Hall, Great Eastern Hotel, Liverpool-street, on Wednesday, April 4th, 1923.

The chair was occupied by Mr. C. W. L. Glaze and the vice-chair by Mr. W. Sime. There were also present Mr. S. A. Parnwell, General Manager, Southern Area of the London and North-Eastern Railway, and Mr. H. N. Gresley, Chief Mechanical Engineer of the London and North-Eastern Railway. The party numbered close on 250—including a large number of old retired officers of the railway—and was drawn from practically all parts of the Great Eastern Section. Letters of regret for absence were read from Mr. R. Stewart and Colonel Galloway, director, London and North-Eastern Railway.

After the loyal toasts, Mr. A. P. Turner, retired district locomotive superintendent, proposed "The London and North-Eastern Railway," which was responded to by Mr. S. A. Parnwell, who in his reply took the opportunity of expressing to Mr. Hill his warm thanks for the deep friendship and high technical assistance which Mr. Hill had extended to him.

The gifts, which consisted of a gold wrist watch and a pair of field binoculars for Mr. Hill and a lady's toilet case for Mrs. Hill, were then presented by Mr. Glaze, who asked Mr. Hill to accept these offerings as some indication of the feeling that his late staff entertained for him, and requested him to hand Mrs. Hill's present over to her with a message of thanks for the excellent way in which, they felt sure, she had always supported her husband in any matters for the welfare of those serving the railway with him. The watch was inscribed "To A. J. Hill, Esq., from his Staff, 31st March, 1923." Invited speeches were then delivered by Mr. H. N. Gresley and several old Stratfordians, namely, Mr. W. D. Craig, late chief draughtsman; Mr. William Lucas, late foreman painter; Mr. J. Wilson, late district locomotive superintendent.

Mr. Hill, in returning thanks for the presents, expressed his indebtedness to his staff for the loyal support he had had from them throughout, which had enabled him to carry on his duties with what he thought he was fully entitled to regard as success. He felt that Mr. Gresley could rely with absolute certainty on the same co-operation that he—the speaker—had received.

LAUNCHES AND TRIAL TRIPS.

GLENCELDIE, steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Canadian Great Lakes and Canals; dimensions, 252ft. by 42ft. 6in. by 20ft. 6in. Engines, single-screw triple-expansion; constructed by the builders; launch, April 3rd.

KOHISTAN, steel screw steamer; built by William Gray and Co., Limited; to the order of F. C. Strick and Co. (1923), Limited; dimensions, 362ft. 9in. by 52ft. 6in. by 29ft. 4½in.; 6700 tons deadweight. Engines, triple-expansion, 26in., 42in., 70in. by 48in. stroke, pressure 200 lb.; constructed by the builders; launch, April 4th.

PENDEEN, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks, Limited; to the order of the R. B. Chellew Steam Navigation Company, Limited; dimensions, 389ft. by 51ft. 3in. by 27ft. 3in.; to carry 7300 tons. Engines, triple-expansion, 26in., 42in. and 70in. by 48in. stroke; constructed by Blair and Co., Limited, Stockton-on-Tees; launch, April 4th.

BARDISTAN, steamer; built by Wm. Gray and Co., Limited; to the order of F. C. Strick and Co., Limited; dimensions, 362ft. 9in. by 52ft. 6in. by 29ft. 4½in.; 6900 tons deadweight. Engines, triple-expansion, 26in., 42in., 70in., by 48in. stroke, pressure 200 lb.; constructed by the builders; trial trip, April 7th.

The Generation of Electricity in Great Britain.

In preparing the analysis and summaries of fuel consumption and units generated during the year ending March 31st, 1922, the Electricity Commissioners have given effect to a number of suggestions for increasing the utility of the compilation. The present return differs from the previous one and from those formerly issued by the Coal Controller in several important respects. In lieu of the coal transport reorganisation scheme of areas the present return is based primarily upon the areas of the electricity districts provisionally or finally determined. The remaining portions of Great Britain which are not at present included in any electricity district have been grouped in appropriate areas for the purposes of the compilation only, but these areas will continue to be used in preparing the annual analysis, &c., until such time as they fall within the limits of future electricity districts. These areas are fully described in a table, and it is explained that they have no necessary relation to any further electricity districts which may be determined by the Electricity Commissioners in the future. The grouping of generating stations in sizes, based upon

TABLE I.—*Group Classification according to Units Generated.*

Group letter.	Number of units generated at station.
A	Over 200,000,000
B	Between 100,000,000 and 200,000,000
C	" 50,000,000 and 100,000,000
D	" 25,000,000 and 50,000,000
E	" 10,000,000 and 25,000,000
F	" 5,000,000 and 10,000,000
G	" 2,500,000 and 5,000,000
H	" 1,000,000 and 2,500,000
I	" 500,000 and 1,000,000
J	" 250,000 and 500,000
K	" 100,000 and 250,000
L	" 50,000 and 100,000
M	Under 50,000

the number of units generated at each during the year, has been considerably extended, the present return containing thirteen groups as compared with four in the previous return.

TABLE II.—*Steam Stations.*

Group (see Table I.).	Number of stations.	Total units generated by steam plant.	Total fuel consumed.	Average fuel consumption per unit generated.	Lowest fuel consumption at any station per unit generated.	Highest thermal efficiency for any station (approximate).
			Tons.	lb.	lb.	Per cent.
A	2	459,153,708	431,784	2.10	1.74	17.20
B	7	980,857,060	1,055,646	2.41	1.98	15.25
C	10	631,572,849	790,424	2.80	1.70	16.50
D	25	960,319,666	1,284,867	3.00	2.22	14.10
E	65	993,369,909	1,494,727	3.38	2.04	15.70
F	51	375,505,555	668,866	3.98	2.80	11.17
G	48	167,815,084	376,609	5.03	3.24	11.21
H	74	122,166,998	310,621	5.69	3.56	9.12
I	39	27,916,462	95,718	7.68	4.61	7.20
J	26	8,959,735	34,333	8.58	5.44	5.80
K	22	3,702,866	21,172	12.80	5.89	6.85
L	18	1,207,532	11,819	20.90	6.80	4.10
M	9	217,010	1,001	10.33	4.44	6.07
Totals	396	4,732,824,434	6,577,587	3.11		

NOTE.—Where the calorific value of the fuel was not specified in the returns, the following average values have been taken for calculating the thermal efficiency, viz.:—Coal, 10,500 B.Th.U. per lb.; coke, 6000 B.Th.U. per lb.; oil, 18,000 B.Th.U. per lb.

TABLE III.—*Gas Producer Stations.*

Group (see Table I.).	Number of stations.	Total units generated.	Total fuel consumed.	Average fuel consumption per unit generated.	Lowest fuel consumption at any station per unit generated.	Highest thermal efficiency for any station (approximate).
			Tons.	lb.	lb.	Per cent.
A, B, C, D, E, F, G	Nil					
H	2	3,599,530	2,805	1.74	1.67	15.12
I	4	2,172,282	3,251	3.35	2.33	11.25
J	14	4,888,356	6,145	2.82	1.83	12.44
K	19	3,091,314	3,718	2.77	1.39	15.60
L	15	1,069,688	1,347	2.82	1.97	12.30
M	6	221,539	402	4.06	3.30	7.95
Totals	60	14,952,709	17,668	2.64	—	—

NOTE.—Where the calorific value of the fuel was not specified in the returns, the following average values have been taken for calculating the thermal efficiency, viz.:—Anthracite, 13,000 B.Th.U. per lb.; coke, 6000 B.Th.U. per lb.

TABLE IV.—*Oil Engine Stations.*

Group (see Table I.).	Number of stations.	Total units generated by oil-driven plant.	Total fuel consumed.	Average fuel consumption per unit generated.	Lowest fuel consumption at any station per unit generated.	Highest thermal efficiency for any station (approximate).
			Tons.	lb.	lb.	Per cent.
A, B, C, D, E, F	Nil					
G	2	6,315,803	8,905	3.16	2.79	8.56
H	6	9,730,144	8,245	1.90	0.65	28.10
I	11	7,440,716	6,175	1.86	0.65	29.15
J	19	6,413,348	4,730	1.65	0.67	27.45
K	9	1,505,740	1,225	1.82	0.69	27.50
L	1	15,145	10	—	—	—
M	5	130,179	106	1.83	1.54	12.29
Totals	52	31,551,075	29,396	2.08	—	—

NOTE.—Where the calorific value of the fuel was not specified in the returns, the following average value has been taken for calculating the thermal efficiency, viz.:—Oil, 18,000 B.Th.U. per lb.

TABLE V.—*Stations Generating by Waste Heat, Refuse Destructor, Towns Gas and Water Power.*

Group (see Table I.).	Waste heat.		Destructor.		Gas engine stations using towns gas.		Water power.		Total.	
	Units generated.	No. of stations.	Units generated.	No. of stations.	Units generated.	No. of stations.	Units generated.	No. of stations.	Units generated.	No. of stations.
A	—	—	—	—	—	—	—	—	—	—
B	3,669,573	1 (1)	—	—	—	—	—	—	3,669,573	1 (1)
C	—	—	—	—	—	—	—	—	—	—
D	1,783,052	1 (1)	2,987,745	1 (1)	—	—	—	—	4,740,797	2 (2)
E	11,899,577	3 (3)	5,368,842	7 (7)	—	—	18,763,793	1	36,032,212	11 (10)
F	25,130,278	5 (1)	45,172	2 (2)	—	—	7,092,780	2 (1)	32,268,230	9 (4)
G	8,732,900	2	4,769,600	3 (2)	—	—	1,492,700	1 (1)	14,995,200	6 (3)
H	2,237,100	1	3,184,524	5 (7)	1,366,376	1	84,438	1 (1)	6,872,438	11 (8)
I	818,625	2 (1)	243,158	2 (2)	2,047,868	3 (1)	710,336	5 (5)	3,819,987	12 (9)
J	277,800	1	859,064	5 (5)	—	—	391,474	2 (1)	1,528,338	8 (6)
K	109,500	1	228,345	1	241,240	1	296,758	3 (3)	875,843	6 (3)
L	—	—	41,900	1 (1)	149,300	2	197,104	4 (2)	388,304	7 (3)
M	—	—	—	—	69,135	3 (1)	77,644	3 (1)	146,799	6 (2)
Totals	54,628,405	17 (7)	17,728,350	30 (27)	3,874,029	10 (2)	29,107,036	22 (15)	105,337,820	79 (51)

NOTE.—The figures in brackets show the number of "composite" stations which are also classified in Tables II., III., and IV., according to the type of the prime movers generating the major portion of the output.

The analyses have also been subdivided to deal with (*a*) steam stations, (*b*) gas-producer stations, (*c*) oil engine stations, and (*d*) other stations, including those which are not classifiable on the basis of thermal efficiency. Following the procedure adopted last year, stations have been placed in their respective groups and areas on the basis of thermal efficiency, but subject to certain exceptions. In the case of composite stations employing prime movers of different kinds, each station has been classified in accordance with the type of prime mover by which the major portion of the total units were generated, and the total fuel consumption at each station converted into the equivalent value of the class of fuel consumed by the principal prime mover. Table No. 1 gives the group classification according to the units generated, while the next three tables give the fuel consumptions and thermal efficiencies for steam, gas producer and oil engine stations.

There are sixteen stations included in the last tables—II., III., and IV.—which were only in operation during a part of the year. There are also twenty-four composite stations, for which an overall thermal efficiency could not be calculated, the major portion of the output at such stations being generated from waste heat, destructor refuse, town gas, or water power. These forty stations have not been placed in their respective groups or areas, and similar observations apply to twenty-eight other stations where no thermal efficiencies have been arrived at, owing to the output being generated entirely from waste heat, destructor refuse, water power, &c.

It will be noted that there are fifty-one composite stations included in Table V., these stations also being classified in the three previous tables in accordance with the type of the principal prime movers in each station. In twenty-seven cases in which the approximate overall thermal efficiency has been calculated, the very small proportion of units generated by waste heat, refuse destructor, town's gas, or water power, has been neglected as having no material bearing on the thermal efficiency. These twenty-seven stations are placed in their respective groups and areas, but the other twenty-four composite stations in the last table have not been placed, as previously indicated.

A long table published in the return contains a comprehensive summary of the best results as regards fuel consumption per unit generated, and also thermal efficiency, for each class of station, not only in respect of its own area or group, but also in relation to the stations in other areas or groups. A summary of area results is also given in another table, which shows the total units generated, the classes of station, the fuel consumption, &c., in each area.

IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, May 10th and 11th, 1923. The following papers will be presented:—

1. C. A. Ablett, "Economic Principles Governing the Use of Electrical Power in Iron and Steel Works."
2. J. O. Arnold, F.R.S., "On the Co-relation of the Chemical Constitutions of 'True Steels' to their Micrographic Structures."
3. C. R. Austin, "Some Mechanical Properties of a Series of Chromium Steels."
4. L. E. Benson and F. C. Thompson, "Some Experiments on Grain-growth in Iron and Steel."
5. H. C. H. Carpenter, F.R.S., "The Production of Single Metallic Crystals and some of their Properties."
6. F. Clements, "British Steel Works Gas-producer Practice."
7. T. P. Colclough, "The Constitution of Basic Slags—its Relation to Furnace Reactions."
8. C. H. Desch and A. T. Roberts, "Some Properties of Steel Containing Globular Cementite."
9. C. A. Edwards and C. R. Austin, "A Contribution to the Study of Hardness."
10. J. E. Fletcher, "Some Characteristics of Moulding Sands and their Graphical Representation."
11. D. Hanson and J. R. Freeman, "The Constitution of the Alloys of Iron and Steel."
12. E. J. L. Holman, "Note on a Value for the Surface Tension of Iron Sulphide."
13. K. Honda and T. Murakami, "The Structural Constitution of Iron-Carbon Silicon Alloys."
14. J. J. A. Jones, "The Ac1 Range in Alloy Steels."
15. J. W. Landon, "Change of Density of Iron due to Over-strain."
16. F. C. Langenberg, "An Investigation of the Behaviour of Certain Steels under Impact at Different Temperatures."
17. T. Matsushita, "Some Investigations on the Quenching of Carbon Steels."
18. L. Northcott, "A Note on Temper Carbon."
19. H. O'Neill, "Variation of Brinell Hardness Number with Testing Load."
20. T. F. Russell, "The Potential Energy of Cold Worked Steel."
21. J. Stead, "The Cold Working of Steel with Reference to the Tensile Test."
22. E. R. Sutcliffe and E. C. Evans, "The Reactivity of Coke as a Factor in the Fuel Economy of the Blast-furnace."
23. F. C. Thompson and A. Goffoy, "The Changes in Iron and Steel Below 400 deg. Cent."
24. J. H. Whiteley and A. Braithwaite, "Some Observations on the Effect of Small Quantities of Tin in Steel."

The order in which it is proposed to deal with the papers is as follows, the numbers shown in brackets being down for reading so far as time permits:—Thursday, May 10th, morning—Nos. 22, 6 and 10 (24, 18 and 15); afternoon—Nos. 5, 2 and 11 (20, 23 and 4). Friday, May 11th, morning—Nos. 1, 7 and 8 (13, 17 and 12); afternoon—Nos. 9, 16 and 21 (14, 3 and 19).

The annual dinner will be held in the Grand Hall of the Connaught Rooms, Great Queen-street, London, W.C., on Thursday, May 10th, at 7 for 7.30 p.m.

CATALOGUES.

S. E. SAUNDERS, Limited, East Cowes, Isle of Wight.—A new catalogue describing the firm's specialities in motor craft and engines. Particulars are given of a new type of two-stroke inboard portable motor.

HYATT, Limited, 56, Victoria-street, S.W. 1.—The following publications have been received:—"Instruction Card for Assembling the Hyatt Mine Tub Wheel;" "The Application of the Hyatt Roller Bearing to Iron and Steel Works Machinery and Equipment;" and "The Hyatt Roller Bearing as Applied to Iron and Steel Works Machinery."

Ball and Roller Bearings for Locomotive and Carriage Axles.

An interesting experiment has been under trial for some years on the Swedish State Railways. In 1914–5, ten four-cylinder compound 4–6–2 engines were constructed for the heaviest main line express service. The bogie and trailing axle-boxes of the locomotive and the bogie axle-boxes of the tender were fitted with S.K.F. ball bearings, as shown in the drawing, Fig. 2. The two radial bearings are of the well-known S.K.F. self-aligning type, and the endway movement is, as will be observed, taken by a ball thrust bearing.

The heavy load and duty required for locomotive work proved these bearings to be too weak, and a number of the balls were damaged in service. To meet the difficult conditions the roller bearing, which is also of the S.K.F. type shown in the drawing, Fig. 3, has been designed, and is being experimentally tested on one of the bogies. It is much stronger and more solid than the ball bearing arrangement. The spherical roller bearing at the outer end of the journal is put up to allow a lateral clearance of ¼ mm. to ½ mm. between the race and the axle-box casting. No greater clearance is allowed, since this bearing has to take the end thrust. For the inner cylindrical roller bearing no lateral clearance is given, but it will be noticed that the outer race on which the rollers run is slightly convex, thus allowing the latter some freedom of movement.

The locomotive department of the Swedish State Railways states that the tests with this bearing have not continued sufficiently long to prove whether the arrangement is entirely satisfactory for locomotives.

For railway carriages a somewhat similar arrangement has proved very successful, and the Swedish State Railways have recently ordered 170 bogies for coaches to be supplied with these bearings, which are made by the Skefko Company. The engine—Fig. 1—which is fitted with these roller bearings is a four-cylinder compound with coupled wheels 6ft. 2in. diameter, bogie wheels 3ft. 2in. diameter, and trailing wheels 3ft. 7½in. diameter. The high-pressure cylinders are 16½in. diameter, and the low-pressure cylinders 24.8in. diameter, with a common stroke of 26in. Boiler pressure 185 lb. per square inch. The double bogie tender is of peculiar design, with water tank of semi-circular section.

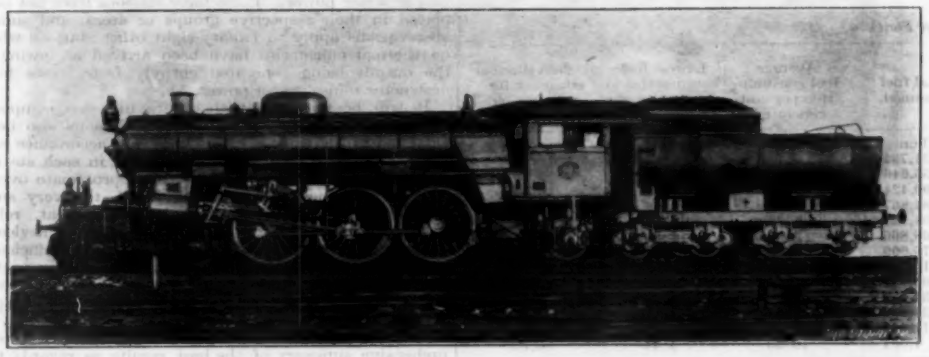


FIG. 1—SWEDISH STATE RAILWAYS—LOCOMOTIVE FITTED WITH ROLLER BEARINGS

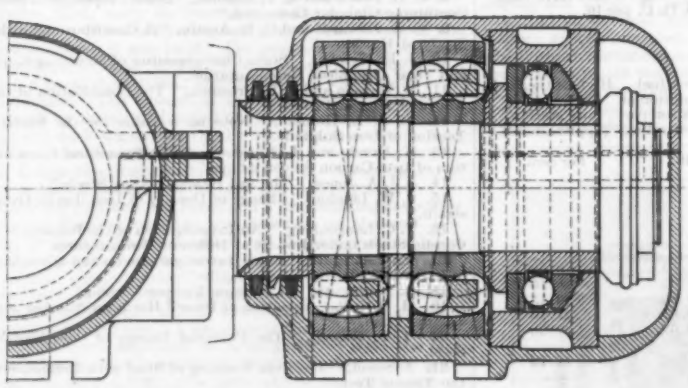


FIG. 2—S.K.F. BALL BEARING AS FITTED TO LOCOMOTIVE

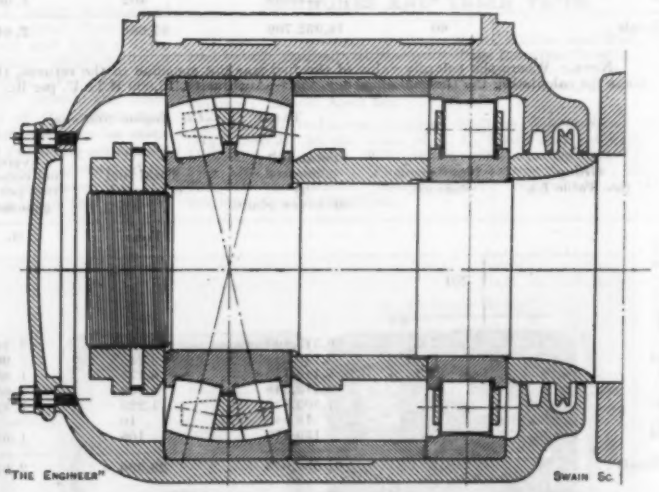


FIG. 3—S.K.F. ROLLER BEARING AS FITTED TO LOCOMOTIVE

An experimental rubber-covered roadway is being laid at Manchester near the entrance to one of the large rubber factories. Instead of the usual method of laying small blocks of rubber singly, as in the case of wood paving, large slabs of rubber, 2in. thick, are used, each slab weighing about 600 lb., so that the possibility of creeping or lifting is reduced. The slabs are also reinforced at intervals with steel bars, which keep them rigid while retaining the necessary pliability to ensure noiselessness. Part of the roadway is laid with smaller slabs of the same type, interlocked with each other, and the respective merits of the two methods will be carefully observed. The whole is placed on a concrete foundation, and the joins are made with tar.

Shipbuilding in the First Quarter of the Year.

Lloyd's Register shipbuilding returns, for the first three months of the year, show for the first time since March, 1921, an increase, as compared with the previous quarter, in the tonnage under construction in Great Britain and Ireland. The tonnage being built at the end of March, viz. :—1,492,138 tons exceeds by about 23,500 tons the figures given for December 31st, 1922. The total still includes a considerable amount of tonnage—181,000 tons—on which work has been suspended for some time. Deducting that amount in order to enable a comparison to be made with figures for normal times, the tonnage actually under construction in Great Britain and Ireland now amounts to 1,311,000 tons. The average tonnage under construction during the twelve months immediately preceding the war was 1,890,000 tons, *i.e.*, 579,000 tons more than the present figures. As compared with the figures for the quarter ended December 31st, 1922, there was a decrease in the tonnage launched, but a considerable increase in the tonnage commenced in Great Britain and Ireland during the past quarter, the tonnage of vessels launched being 32,217 tons less and of those commenced 124,016 tons more.

The tonnage commenced during the quarter ended December 31st, 1921, amounted to 55,290 tons; a slight further reduction took place during the following quarter, and in the course of the second quarter of 1922 the figures reached the lowest level, viz. :—38,877 tons. During the third quarter there was an increase of about 44,000 tons. During the last three months of 1922 the figures reached within 30,000 tons of the total launched during the same period; and for the first quarter of 1923 the tonnage commenced—355,203 tons—actually exceeds by 126,832 tons the tonnage launched.

The total merchant tonnage being built in other countries is 1,367,934 tons, but that figure includes about 148,000 tons upon which work has been suspended, leaving about 1,220,000 tons actually under construction; the latter figure is 50,000 tons less than at the end of December, 1922. The figures for the leading countries abroad are :—Germany and Danzig, 343,027 tons; France, 209,581 tons; Italy, 185,001 tons; United States, 173,762 tons; Holland, 121,321 tons; and Japan, 83,357 tons.

The number and tonnage of vessels launched in the world during the quarter amounted to 442,522 tons, of which 228,371 tons were launched in Great Britain and Ireland, 70,462 tons in Germany and Danzig, 53,212 tons in the United States, and 90,477 tons in other countries. The tonnage commenced in the world during the same period amounted to 530,621 tons, of which 355,203 tons were commenced in Great Britain and Ireland. These totals, however, do not include vessels commenced in Germany during the quarter, such information not being yet available. The total world tonnage on the stocks, 2,860,072 tons, includes 329,000 tons—of which 181,000 tons are in Great Britain and Ireland—on which work is suspended. The tonnage actually under construction is thus 2,531,000 tons, which total is 915,000 tons below the highest pre-war record reached on June 30th, 1913, viz. :—3,446,538 tons.

The returns show that there are at the present time 44 steamers and motor vessels, each of over 1000 tons, with a total tonnage of 247,793 tons, under construction in the world for the carriage of oil in bulk. Of the total, 21 of 137,520 tons are under construction in Great Britain and Ireland. The tonnage of vessels now being built in the world which are to be fitted with internal combustion engines, amounts to 327,232 tons. There are at the present time under construction in the world 50 vessels, each of 10,000 tons and upwards, of which 30 are being built in Great Britain and Ireland.

Of the vessels under construction in the world—which total excludes vessels, the construction of which has not actually been commenced, and also all vessels of less than 100 tons—398 of 1,455,079 tons are under the inspection of the society's surveyors, with a view to classification in Lloyd's Register Book.

Compressing Acetylene.

An article by Mr. A. D. Risteen in the monthly *Journal* of the American Society of Mechanical Engineers deals with the precautions which should be taken in the compression of various commercial gases, and from it we take the following hints on the compression of acetylene.

No person, the author says, should ever undertake to compress acetylene unless he fully understands the properties of the gas and knows exactly what it is permissible to do and what he must carefully avoid doing. This is not meant to imply that the compression of acetylene is a dangerous operation when it is performed under the direction of a properly qualified man, but is intended as a special note of warning to those who are tempted to compress the gas without first understanding its properties. Acetylene is an endothermic compound, and this formidable word has frightened a great many persons who do not understand its exact significance. It merely means that heat is absorbed—instead of emitted—when acetylene is formed from its constituent elements. Now, it is well known that substances of this kind are likely to be more or less unstable under certain conditions, and acetylene is no exception to the rule; but the conditions under which the instability exists are well known, and it is only the man who does not understand them, or who is pleased to ignore them, who gets into trouble.

In compressing acetylene it is important to keep the temperature of the gas as low as practicable at all times. Expressed in more definite language, this means that the compression must be effected by a pump moving with a very low piston speed, and that it must be performed in not less than three stages. It also means that the pump cylinders should be kept as cool as practicable by a plentiful supply of water drawn from the coolest available source. The author does not state any definite temperature at which the gas may become instable during the act of compression, and in fact it is doubted if anyone knows what that temperature might be. It certainly is not safe, however, to store acetylene in otherwise empty cylinders, at the pressure at which the compressor pumps deliver it. There appears to be a time element involved here, and it is probable that a certain amount of polymerisation gradually occurs in strongly compressed acetylene—except when it is stored in special receptacles containing suitable porous material charged with liquid acetone—so that in the course of time small quantities of other more sensitive substances are formed, which serve to lessen the stability. At all events, acetylene should not be stored in an otherwise empty tank at a pressure of more than 15 lb. per square inch greater than the normal pressure of the atmosphere. Explosions in the compression pumps, and in the delivery pipes leading from them, are, nevertheless, exceedingly rare if the compression is effected as described above. In fact, the author mentions only one case of the sort, and this was precipitated by the breakage of a steel valve spring, which quite possibly struck a spark and thereby caused the development of a high temperature within the tiny space filled by the spark itself.

Oil may be used for lubricating the cylinders of acetylene-compressing pumps, but it should afterward be removed by passing the compressed gas through suitable separators as it leaves the compressor. And immediately upon leaving the oil separator, the acetylene should be passed into the storage cylinders, which, as previously stated, must be filled with a special porous, solid material thoroughly impregnated by liquid acetone, which dissolves the acetylene and holds it safely in solution.

GERMAN SUBMARINE CR

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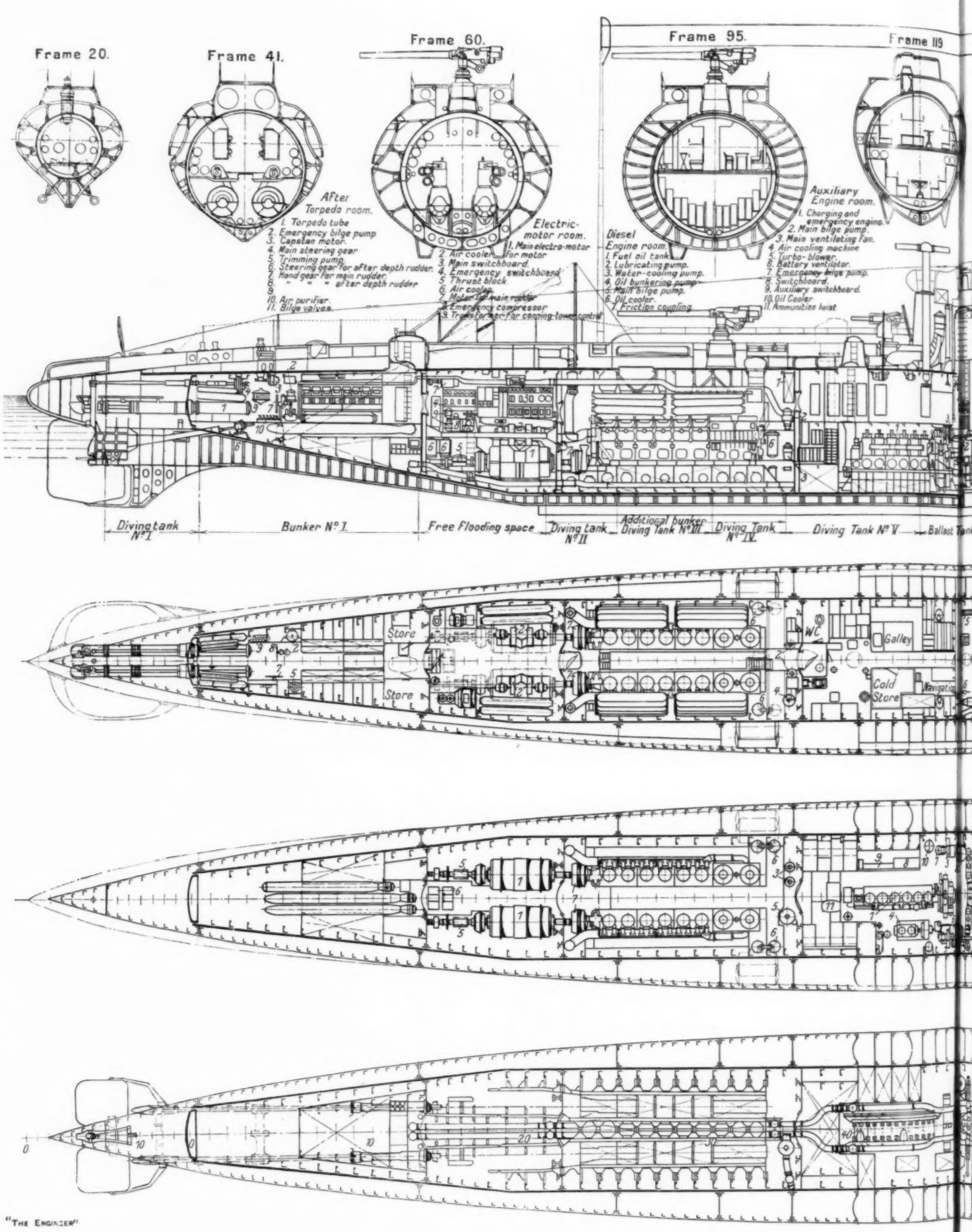

"THE ENGINEER"

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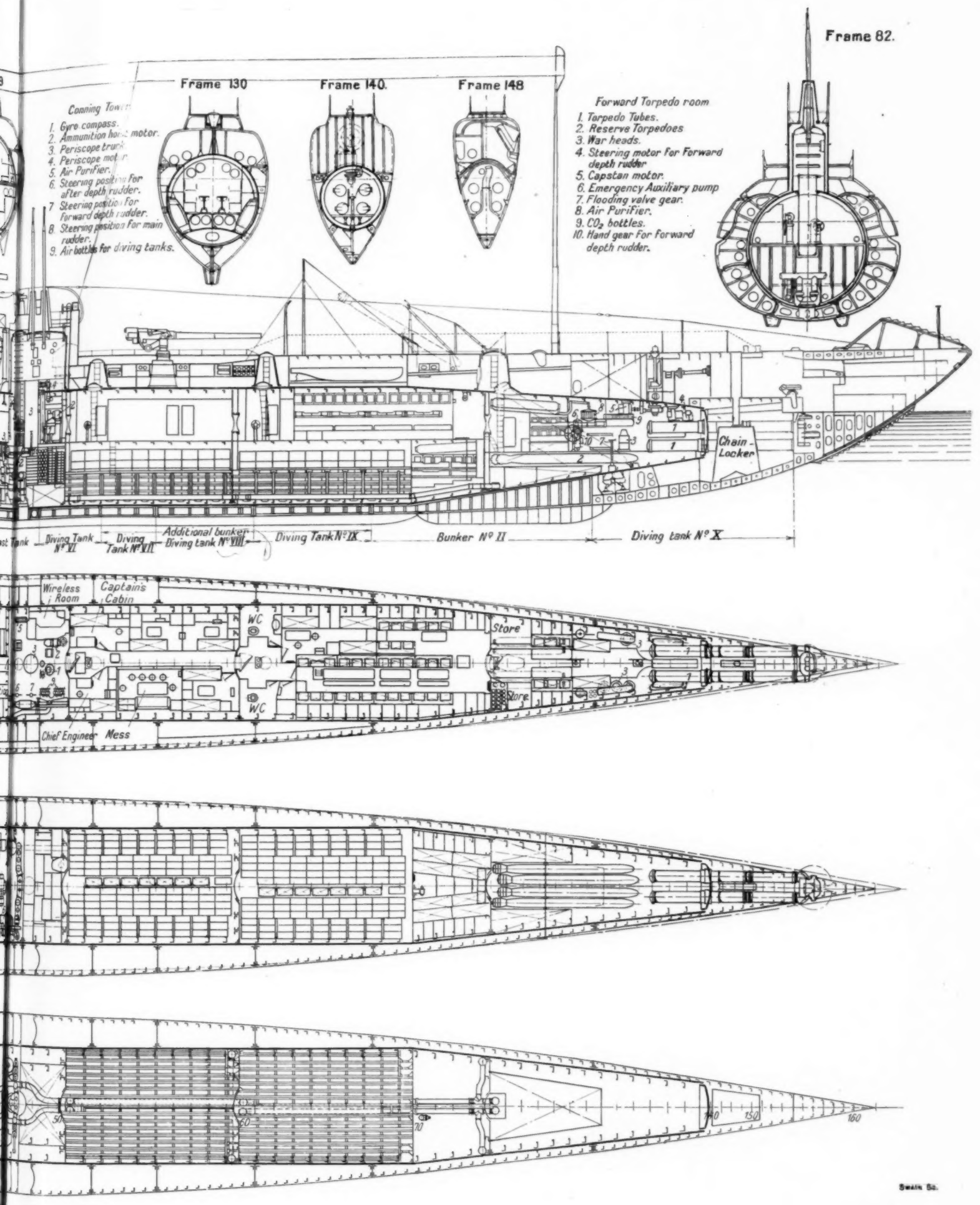


It should not be necessary to issue a warning against mixing other gases with acetylene in the storage tanks, or using acetylene storage cylinders for any purpose whatsoever, except for holding pure, unmixed acetylene—in addition to the safety filling.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Birmingham Quarterly Meeting.

To-day (Thursday) was quarter day on the Birmingham Iron and Steel Exchange, and though there was a large and representative gathering there was not much freedom of bargaining, and the meeting on the whole was decidedly quiet. Buying has fallen off in most departments a good deal of late, though there would have been a ready sale for pig iron and half products if quick delivery could have been relied on, but this is a condition with which producers could comply to a very limited extent only. On all hands supplies are decreasing, whilst consumers who would be glad to have material in order to cope with the orders on their books or awaiting them, are deterred by the high prices. They are strongly disinclined to buy forward except in special circumstances. Manufacturers are the victims of circumstances, and until these change there is not likely to be any modification of the situation, either in respect of prices or increased production. Ironmasters' costs will be further increased by the 2½ per cent. advance in ironworkers' wages which has just taken effect. Shortage of raw material is responsible for prolonging the inactivity in many departments of the iron and steel trade. Uncertainty as to delivery, and the high prices which consumers are required to pay on the open market have suppressed demand to some extent, and this was very noticeable at the quarterly meeting. Till the trade became dislocated by the continental raid on coke, there had been an encouraging expansion, month by month, in the output from the ironworks, as reflected in the ascertainments of the Midland Iron and Steel Wages Board. In January and February the tonnage approximated to the pre-war normal, but it is feared that the returns for March and April will be less satisfactory. The decline in output is not so marked as the shrinkage in new business. It may be that the crisis will pass before there is any very serious disorganisation in the finishing branches. Prices generally for the finished material have, however, already risen to a degree which has resulted in buyers showing a tendency to fight shy of considering anything in the nature of forward contracts. At to-day's meeting a few good orders were given out, but inquiries for the future were tinged with a note of diffidence and lack of confidence. The holiday break does not appear to have done much towards augmenting the pig iron supply. It was stated on 'Change to-day that another blast-furnace is about to be started in the Dudley area, but numerous owners of plant are unable to get sufficient coke to justify re-lighting. Supplies are, in fact, insufficient for the plants already at work, and furnaces very commonly have to go on slack blast for want of fuel. There was no appreciable change in pig values to-day. Some smelters were asking more for foundry iron, but it merely signified that they had only a limited quantity to sell, and meant to exercise discrimination as to where it should go. The coke position was reported to be no easier. Most steel materials were dearer. Both steel and ironmasters are expecting to benefit considerably from the improvement in the rolling stock works. It is anticipated that they will shortly be called upon to supply thousands of tons of material for the building of railway vehicles. The conflict in the labour world was a topic much discussed, and Midland iron and steelmasters, in common with the principals of foundry and general engineering firms, viewed the disputes in the building trade, railway workshops and the agricultural industry, with considerable anxiety.

Finished Iron Trade.

Makers of finished iron, at the quarterly meeting to-day, reported that they are better furnished with orders than they were, the makers of best material being most favoured. A lot of marked iron is being demanded for shipbuilding, chain and anchor making, and various engineering requisites. Most owners of warehouses, producers stated, have also taken the opportunity to renew their stocks. Mills keep well employed, mostly on orders to cover current needs, there being little disposition to enter into speculative business. Marked bars are now firmly established on the recently fixed basis of £14. Makers of merchant quality bars are also busy, but could handle a good deal more work, for there is still a large percentage of idle plant. Prices have gradually appreciated during the quarter, most firms now getting £12 10s. for Crown quality. Nut and bolt bars are quoted at £11 10s. to as high as £12 in one or two exceptional cases, but with a general maximum of £11 15s. There are no signs of giving way in this branch, even although the demand from the nut and bolt works is quiet. This may be partly accounted for by the fact that in the nut and bolt trade of this district steel is again threatening the position of iron owing to the distortion of market values. The only material on offer from Belgium is No. 3 iron, quoted at £9 15s. Antwerp, or £11 delivered here. This figure approximates too closely to the Staffordshire quotation to offer attraction, and very few orders are placed. The tube trade of the Black Country is showing a great deal of activity and absorbing large quantities of iron and steel strip. Wrought iron gas tube strip has been advanced, some makers demanding as much as £13 10s. per ton. Steel strip can be bought at £12. Many tube buyers specify for iron on account of the better resistance to corrosion.

Steel Business.

Steelmasters attending the market at Birmingham to-day wanted more for their products, especially structural material, than they were prepared to accept a week ago. Most descriptions were up by quite 5s. per ton. During the quarter demand has increased considerably; indeed, in some quarters it is described as a small "boom." Expansion in the steel trade is rather a difficult business by reason of the shortage in scrap and the difficulty of obtaining adequate and prompt supplies of billets. For soft billets nothing under £9 15s. could be heard of, and some makers were demanding £10 up to as high as £10 10s. This is a prohibitive figure for re-rollers who are unable to get more than £11 10s. for the finished product. The consumers intimated that they would welcome a revival of foreign competition in this department; but there is practically no continental steel offering just now, although there is a good deal to be delivered on old contracts, and accumulations at Antwerp are understood to be heavy. Native supplies are almost as difficult to secure, and the quarterly meeting discovered that there were practically no supplies for delivery for some weeks to come. Sheet bars are based on £9 15s. in this district. High carbon billets range from £10 10s. to £10 15s. Small steel bars command £12 and upward. The Lancashire price is £13, both for steel and iron bars. Staffordshire makers of joists are asking £10 10s., and sections have firmed up 5s. per ton. Makers of ship, bridge and tank plates are not prepared to entertain less than £10 15s. The more common quotation is £11. The continental position causes uneasiness, but in view of the firmness of prices, a steady trade continues to be done.

Galvanised Sheets.

Competition for business in galvanised sheets caused, at the meeting in Birmingham to-day (Thursday), some weakening of prices. Supplies were offered at £19 10s. to £19 15s., but it was stated that sales could be effected at a somewhat lower level. Makers of black sheets have plenty of work on hand, the motor trade calling for fairly large quantities of thin material. Tinplate was also in good demand, in spite of the substantial additions to prices lately made by South Wales. So far, the addition to the quotation has not checked the call for this material for motor building.

Pig Iron.

There has been no modification in the pig iron position, and the paradoxical position of good business being neglected on account of lack of coke will apparently remain until the continental situation changes. There is an acute scarcity of both foundry and forge numbers, and prompt iron cannot be bought. Values are exceedingly firm. The ruling price for No. 3 foundry iron is £5 10s. Northamptonshire furnaces have sold all the pig iron they intend to dispose of for the present. For deliveries in July and August £5 10s. is quoted. Customers generally prefer to take their chance later rather than commit themselves at that figure. For forge material the figure is £5 5s., but the supply is so scarce that works are at a standstill for iron.

Rolling Stock Works Busy.

The builders of rolling stock in this district have more work on hand than for some years. Orders for thousands of railway coaches on home and foreign account have been placed with Midland firms within recent months. Present orders in some cases are stated to be sufficient to keep the plant running for a year at least. In some instances extensions of plant are in course of arrangement, for the amalgamation of railways has already led to the placing of some large orders which have been for some time in suspense, and further development schemes are expected, so that some large contracts should be issued in the near future.

Wage Revision.

Variations in the minimum rates of wages for certain classes of male workers in the stamped or pressed metal wares trade have become effective this week. The general minimum time rates for adults of the classes affected are as follows:—Braziers, burnishers, or drop stampers, 1s. 1d. to 1s. 4½d. an hour, according to grade; dippers, 1s. 1d.; dippers who are also bronzers, 1s. 1d. to 1s. 4½d., according to grade; annealers, 1s. 1d.; polishers, 1s. 1d. to 1s. 5d., according to grade. There are corresponding reductions for the younger classes of workers.

LANCASHIRE.

(From our own Correspondents.)

Manchester, Thursday.

General Outlook.

The general condition of the markets in South Lancashire for iron and metals may be described as quiet; but this does not imply that there is any weakness in the matter of prices. There is not so much new business passing as was expected when the holiday influences were over; and some people think that the higher prices are frightening the buyer away. This, however, is rather a doubtful explanation of the quietness, because one cannot find that people are looking for any lower prices, at any rate in the near future. It is fairly safe to assume that present prices are good for the next two months; although any one who attempted to forecast the market six months hence would certainly be taking a great risk. The prices in the non-ferrous group of metals may be fairly safe; but it is obvious that those in the ferrous group are far too much dependent upon abnormal conditions on the Continent.

Metals.

The market for standard copper has been rather steadier for the last week or so. The advance seems to have been checked for the present, but there is a good deal of uncertainty in the market as to future prospects. Speculation is rather less active than it was, and this seems to indicate that operators are uncertain as to the probable course of prices. It has been reported that the consumptive demand in America is slackening. The differences between electrolytic and best selected ingot copper have tended to lessen during the last month, and this perhaps is an indication that the engineering demand for copper is rather better than it was. One would like to believe that this is the case, and that the engineering trade is now using up more refined ingot copper; although one cannot say that the industry in question is yet in a flourishing condition. The official prices for manufactured copper and brass have not been altered this week, and the glaring inconsistencies in the list are still an offence to common sense. There has been some considerable improvement in the demand for non-ferrous metal scrap during the last few weeks, and this is perhaps a sign that things are improving; for the difficulty in selling old metals, even at prices far below the intrinsic value, has been an unfavourable market feature for quite a long time. This week dealers are offering up to £67 per ton for clean scrap copper, and up to £54 for good lots of gun-metal. It is not so long ago that they would not pay more than £44 for the latter. The market for tin has been rather a disappointment to the "bull" operators of late. It was expected that favourable statistics would give the market an impetus when business was resumed after the holiday; but these statistics for March are not nearly so favourable as was anticipated; and, moreover, the shipments from the East were larger than was anticipated. The market has, therefore, been rather dull. Nevertheless, tin at present prices is quite high enough for the convenience of trade, and one would not be sorry to see a further considerable fall, although this does not appear to be very likely at the moment. The markets for lead and spelter have both been fairly steady of late, although the latter has given way a little. The American price for lead keeps firm, and while this is the case it is difficult for our market to fall very much. There is, however, plenty of lead offering in this country. Buyers of spelter seem to have been keeping off the market lately, and with rather larger supplies from Belgium and a promise of more German metal, the prices have been rather weak. The demand for galvanised sheets remains good.

Pig Iron.

The position in the foundry iron markets has not altered here, but there is a feeling that prices generally for pig iron have now reached their limit. As the Midland prices are so far below the Cleveland prices, however, it seems possible that these may yet be increased. Consumers here are not yet willing to buy to any extent, and trade is quiet; but, on the other hand, producers are still so far uncertain about future costs of production that they are not pressing sales, or at all anxious to obtain forward orders. The price here for Midland foundry iron is still based on 107s. 6d. to 110s. per ton at the Derbyshire furnaces. With Cleveland iron of similar quality quoted at 127s. 6d. at the furnaces, this Midland price is comparatively low. Delivered in Manchester the iron costs at least 116s. per ton, and ironfounders contend that they cannot get new orders for castings which will justify so high a price. There have been reports to the effect that American furnace coke is now being sold to the Continent; and if this movement develops to any extent it may make a vast difference here; for the only reason for the present prices of pig iron is the shortage of blast-furnace coke. There is productive capacity in this country for much more pig iron than our industries—in their present state—can use, and moreover the production of pig iron is a paying proposition at the present prices. Whether Manchester ironfounders will be able to hold off the market long enough to allow of prices getting easier is of course quite another question; but some of them are evidently hoping to do so.

Steel.

Some sellers of steel here are now asking £12 10s. per ton for round steel bars and up to £11 10s. per ton for steel plates, but it is thought that these are extreme prices. There are sellers of steel angles and joists at £10 12s. 6d. to £10 15s. per ton, and it is difficult to see why there should be nearly £2 difference between angles and round bars.

Scrap.

The market for scrap is quiet, and there is little change in the general condition. The ironworks are offering £5 per ton for heavy wrought scrap, but if, as is expected, the price of bar iron here is raised this week, they might offer £5 5s. to £5 10s. Cast scrap is neglected, and dealers find it difficult to sell even at 15s. to 20s. per ton below the current price of foundry pig iron.

Taxation's Handicap on Industry.

Whatever the new Budget has in store—such, for instance, as the reduction of the income tax—there is a consensus of opinion in trading circles that the corporation tax ought to come to an end. This particular tax is considered both unfair and unjust. Mr. Arthur Balfour, speaking on the subject of taxation to members of the Manchester Luncheon Club on Monday last, said that with the exception of the excess profits duty, the corporation tax interfered most with the making up of sound balance sheets. As long as a tax was of a temporary nature, the authorities would persist in interfering with the way in which stocks were "taken" and balance sheets were made out. In the case of a permanent tax they were much less likely to interfere. Mr. Balfour said our national expenditure was higher than industry and commerce could bear, but he was opposed to the putting off of our sinking fund payments or deferring the facing of our obligations day by day. He said the credit which this country now enjoyed was due to the fact that it faced its obligations as they arose. On the subject of unemployment, Mr. Balfour said that generally labour in this country was absolutely sound. It was, however, sometimes misled by irresponsible people, and he said it was time there was a "Who's Who" of the labour movement, so that one could see where some of the active people came from and what title they had to speak for British

labour at all. Mr. Balfour spoke hopefully of the future of trade. He said that our output of steel ingots was rising month by month, and our imports of raw materials were increasing. Shipbuilding was not as we should like it, but we were still the greatest shipbuilders in the world, and could build more cheaply than any other country.

Cut-throat Competition.

One of the chief troubles in the engineering industry at the present time is the absolutely ruinous policy which many firms are pursuing in the cutting of prices to obtain orders. I have spoken during the last few days to the heads of firms engaged in the various branches of the industry, and from all I heard the same complaint. Without mentioning names or even specifying the particular branch of manufacture to which he referred, a well-known local engineer mentioned an instance to me in which he was particularly interested. To identical specifications the prices variously quoted for a machine were between £1200 and £2000, and I am assured that the lower figure would not cover the cost of materials and labour, to say nothing of establishment charges. In other words, the firm quoting the lower figure was making a dead loss on the transaction. Of course, it may be argued that a firm is sometimes justified in taking orders at a loss for reasons which are not obvious to those not concerned. It is done justifiably in times of great slackness, for instance, in order to find work for the nucleus of a staff; but many of the cases which have been brought to my notice are not justified on this ground, and the policy if pursued can only result in disaster, unless the firms responsible are able to cover up any losses made in one branch of manufacture by the profits made in some other department. In any case, the policy of "throat-cutting" is one which is thoroughly unsound and ought to be capable of being dealt with by the trade organisations which exist for mutual protection.

"From Factory to Face."

This is not the title of a novel. It is that given to a pamphlet recently published by W. T. Glover and Co., Limited, Manchester, the contents being an abstract of a paper relating the history of a colliery cable which was read some time ago by Mr. W. T. Anderson, M.I.E.E., before the North-Western Students' Section of the Institution of Electrical Engineers and other scientific societies. Mr. Anderson has made a very interesting and instructive story out of what would appear to be a most uninteresting subject. He describes very well the method of manufacture of electric cables of various types from the "commercial rod," the methods of transmission of the current, the means for detecting faults, and the different systems of laying cables from the source of power to the pithead, &c. The subject is rendered additionally attractive by means of a number of very good illustrations.

Barrow-in-Furness, Thursday.

Hematite.

The rumours which have been in circulation to the effect that the hematite pig iron trade was showing signs of quietening are very wide of the mark. There is a greater bulk of inquiries than ever there was, and there is little likelihood of all demands being satisfied. Coke governs the situation and dictates the number of furnaces that are to be in blast, and until there is a much bigger quantity of it available there will be little increase in the output. The restricted make is having its effect upon the price of iron which still shows a tendency to rise. Coke being dearer also affects the price. The home trade is developing, as shipbuilders and engineers become busier, and if the Ruhr business were settled the demands by home users would certainly make up to a certain extent for the loss of continental trade. There have been the usual shipments from Barrow, but none of them last week went direct by sea to the Continent. The Scottish trade is full of promise. Special qualities of iron are in good demand.

Iron Ore.

The iron ore trade remains the same. There have been a few shipments of ore from local ports, but the bulk is used in the district. Prices are firm with an upward tendency. Foreign ore is not being imported in large quantities, and some of that which is coming in is being dumped at the docks.

Steel.

The steel trade is moderate. The Barrow works are fairly active, and the rail mill is still engaged on orders. This mill has experienced a good run as compared with the other mills in the district. The hoop mills are still engaged, and the new bar mill is well booked with orders.

Shipbuilding and Engineering.

Further particulars are available about the second of the two vessels ordered from Vickers a couple of weeks ago. The first was for the Donaldson Line, and will be driven by a single set of eight-cylinder internal combustion engines. The second vessel is for the Anglo-Newfoundland Development Company. She will be steam driven, and will have a speed of 11 knots and a displacement of 13,000 tons with a length of 400ft. She is designed to carry newsprint in reels from Newfoundland to Manchester and London. She will have a special stem for negotiating ice and her cabin accommodation is to be of a very high-class order.

SHEFFIELD.

(From our own Correspondent.)

High Prices Checking Trade.

The heavy steel trade still continues to enjoy great activity, and the open-hearth furnace plant, largely though it has been extended since the war, is employed up to three-quarters of its capacity. Several firms are, in fact, on full time, but others have only about half their furnaces in operation. The rolling of the material produced at these furnaces is providing full work for the mills. The steel makers are in arrears with their production and delivery, and would have been glad if Easter had not come just now to cause a short stoppage in their work. But although the amount of trade on hand is so very large, it is not increasing by any means as fast as it did up to a few weeks ago. This alteration is attributed to the substantial rises in price which have taken place with such rapidity. The bulk of the orders now being worked off were given out at lower prices than those now ruling, and since the increases the amount of new business placed has been very small. Few of the local works have enough orders on hand to last many weeks, and they will soon be wanting further contracts.

No Change Likely.

Although the present quotations for steel are to a large extent nominal, and are being paid in comparatively few instances, it cannot be said that there is much prospect of a reduction. As far as pig iron and scrap are concerned, the tendency is still a rising one. The blast-furnaces have sold practically all their output for some time ahead. Basic pig iron is unobtainable, and odd lots of hematite cannot be secured in Sheffield under £7 per ton delivered. For heavy steel scrap, as much as £5 5s. or even £5 10s. is asked by some holders. While the buyers of iron and steel are contending that prices are on an artificial basis, and that the market is sure to collapse with the settlement of the Ruhr difficulty, sellers argue just as strongly that the high prices have come to stay for a considerable time. They maintain that, even if affairs in the Ruhr should be straightened out at an early date, German production could not be restored to its normal level for a substantial time, and they are therefore adopting a confident attitude.

Lighter Steel Departments.

The condition of things in the high-speed steel section does not improve. The call for this expensive material is really trifling, in comparison with the city's means of producing it, and it almost looks as if the position has recently become worse instead of better. On the crucible steel side generally, only a small proportion of the firms can be said to be fairly well off for work. There is a better request for alloy steels for motor and other construction. The season for farm and garden tools has gone on moderately well so far, but the demands of agricultural implement makers for steel and steel parts have been exceptionally light. The increase in the price of mild steel is seriously hitting those makers of files, garden and farm tools who did not cover their requirements early in the year, as they are now having to pay some 50s. a ton more for their material. They are not in a position to recoup themselves by adding this to the price of the finished article, as their seasonal lists have gone out and it is not convenient to alter them.

Important Stainless Steel Development.

The uses of stainless steel are ever extending, and several important developments are foreshadowed at present. The experimental foundries have lately been producing stainless steel castings in considerable variety, and these may be expected to be seen in wide use in industry in the near future. One of the most interesting innovations is the production of stainless steel water taps for baths and lavatories by Gummers, Limited, of the Effingham Brass Works, Rotherham. In view of the great expense and labour which are entailed in cleaning water fittings, this improvement should attract wide attention, especially for use in ships, hotels and public baths, while the ordinary housewife and domestic servant may be expected to appreciate its advantages just as highly. The stainless tap cannot tarnish, it has an attractive appearance, and its wear is practically everlasting. It will, of course, be more expensive than the old variety.

Cutlery and Plate.

There is no improvement to report in the state of the cutlery trade. The stainless steel table knife section is the only really busy one. Contracts for large supplies continue to come forward, but prices are keenly cut, and the orders frequently go to small factories and not to the large, old-established houses. There is scarcely any demand for razors. Some local firms are paying increased attention to the cultivation of trade in cheap knives and forks which are supplied to markets where the standard of living is low. Prospects in pen and pocket cutlery are considered brighter, as it is understood that German makers now find themselves unable to compete with Sheffield in price. In silver and electro-plate, the position remains unsatisfactory. Hotels and restaurants continue to buy on a considerable scale, but there has been a noticeable decline in shopkeepers' sales. A moderate amount of business is being done in spoons and forks and the cheaper table articles. The demand for heavy and expensive silver plate is very poor. The trade was good during the war, when the newly rich were able to invest in household adornments of this kind; but there is no such demand now.

A Petrol-driven Road Roller.

The city surveyor's department of Sheffield has just added an interesting new vehicle to its equipment, in the shape of a road roller driven by petrol instead of by the old-fashioned steam. It is said to be the heaviest petrol road roller in the world. Its weight is 12¼ tons, which can be increased by a ton, if necessary, by filling the wheels with water. The machine, which was made by Messrs. Barford and Perkins, of Peterborough, is driven by a 30–40 horse-power internal combustion engine. The radiator is at the extreme rear of the vehicle. The machine has a big roller and two big wheels at the back. The advantage of this arrangement is that the vehicle can be used at the side of roads where tram lines are laid down.

Orders Received.

Your Barrow correspondent will, no doubt, tell you all about the order which Vickers Limited have received from the Anglo-Newfoundland Development Company for a large new liner to be built at the yard on the North-West Coast, but the matter is of no less interest to Sheffield, as no doubt some of the work will be done here. The Sheffield railway steel departments are still booking good business, and activity in the wagon-building shops is well maintained. The engineering departments are patchily employed, only a minority of firms being well off for work. Several inquiries for steel works plant have been received lately, but the amount of business actually placed has not been large. Boilermakers are doing fairly well.

Municipal Matters.

In connection with its new scheme of refuse collection, Sheffield Corporation is erecting a large garage for the accommodation of electric vehicles. Ministry of Health sanction has now been received for the borrowing of £26,000 for the buildings, and £4000 for electrical equipment and lighting. The Finance Consultative Committee of the City Council has approved of the expenditure by the Electric Supply Committee of £5500 in respect of substations and £10,000 in respect of mains and service lines for them; and by the Highway and Sewerage Committee of £4019—subject to a grant of 60 per cent. of wages being received from the Unemployment Grants Committee—on the cleaning of filter beds at the sewage disposal works. An interesting municipal item is that the price of gas at Doncaster has been reduced by 6d. per 1000ft., as from April 1st, and another is that the municipal gas undertaking at Chesterfield is to spend £5000 on the erection of a show-room.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Ironstone Industry.

There is a prospect of abiding peace in the Cleveland ironstone mining industry. And after peace, prosperity—at least, that is what is suggested as likely during the negotiations on the hours' question, and is being hopefully anticipated on both sides. Recently the miners decided, with some reluctance, to revert to the eight-hour day which prevailed in the industry up to the early part of 1919, and at a conference between the parties on Monday it was agreed that it should become operative as from Monday next, coupled with an advance in the base rates of the lower paid able-bodied datal men. As the outcome of the acceptance of the eight-hour working day the North Skelton mines of Bolckow, Vaughan and Co., Limited, which have been idle for two years, are to be reopened next Monday, and it is expected that work will be restarted at the Lumpsey Mines in about a month's time. The matter of wages for the next three months was also considered at the conference, and the owners agreed to increase the district percentage from 84 to 88, a general advance of 4 per cent. The question of a new sliding scale and standardisation of rates for various occupations at the mines has been left in the hands of a sub-committee of owners' and miners' representatives.

Cleveland Iron Trade.

The demand for Cleveland pig iron seems scarcely so active, but this is probably due to the fact that makers have little iron to sell before the second half of the year, and buyers are not keen to commit themselves so far ahead. It may also be that some consumers are expecting prices to fall, but only a drop in fuel prices will enable a reduction to be made, for iron ore has not shared in the advance, and wages have risen, and will continue to rise under the sliding scale. Moreover, foreign needs are still substantial, and even the earliest settlement of the Ruhr crisis would leave production on the Continent in arrears for some time to come. Thus there does not seem to be much prospect of lower prices. The lack of adequate supplies of coke still prevents an expansion of the output of pig iron. Indeed, some of the makers are experiencing considerable difficulty in maintaining their present output. No. 1 Cleveland is quoted 132s. 6d.; No. 3 G.M.B., 127s. 6d.; No. 4 foundry, 125s.; and No. 4 forge, 120s.

Hematite Pig Iron.

There is also a lull in business in the East Coast hematite pig iron trade, and a slightly easier tendency in prices is discernible. For prompt lots of mixed numbers, 127s. 6d. per ton is still the general market quotation, but makers are selling for June at 125s. per ton.

Iron-making Materials.

The foreign ore trade is extremely quiet. Sales are very difficult to negotiate, consumers having all the ore they require for some time to come. The price of best Rubio ore is nominal at 25s. per ton c.i.f. Tees. There is no easing in the price of coke, 42s. 6d. per ton, delivered at the Cleveland ironworks, being an average price for good medium furnace qualities.

Manufactured Iron and Steel.

Active conditions prevail in the manufactured iron and steel trade. The impossibility of getting any more cheap semi-steel from the Continent has diverted a big volume of business to Northern producers, who can scarcely cope with the demand. In spite of recent advances in price, billets are in strong request, and many producers are working at high pressure. Rising costs have somewhat tended to arrest the inquiry for new ships, and consequently there are only a limited number of specifications for shipbuilding material; but there has been a fair volume of business in railway and constructional material for export. Prices are firmly maintained.

The Coal Trade.

The Northern coal trade is still in a very strong position, though business now rules on quieter lines. All the activity and excitement on the market of a while ago has quite subsided, and, as a rule, the situation is without any special feature. This is chiefly owing to the bulk of the output of the collieries for this month having been contracted for, leaving only second-hand transactions possible, and these only for small quantities. There is just now a want of assurance and confidence in the forward outlook. The Ruhr question is the occasion of uncertainty respecting the possibilities of German trade, and, until the situation there is much clearer than at present, there is not likely to be a heavy forward buying or contract spurt. There are, however, a fuller number of inquiries from other sources, but in a general way the export section of the coal trade is not quite so buoyant as it was a week or two ago. The home trade is picking up, and is likely to improve consistently. Northumberland steam coals are reported to be exceedingly firm in price up to the end of the current half year, but beyond that business is rather slow, buyers holding off in the hope of being able to purchase more cheaply. Gas coals are moderately firm for all classes, and, together with bunkers, are still on the mend. Coking coals are very scarce and firm. The coke market retains all its strong features, foundries of all makes being steady and gas coke in fair demand.

Blast-furnacemen's Wages Advanced.

The ascertainment for the past quarter issued by the Cleveland Ironmasters' Association certifies that the average net selling price of No. 3 Cleveland pig iron was 92/10.69 per ton, an advance of 4/5.95 per ton, as compared with the price for the preceding quarter. In accordance with the sliding scale arrangement there will be an advance in blast-furnaceman's wages of 4.50 per cent., which will raise them to 31.25 per cent. above the standard. Since the beginning of the year the men's wages have been advanced by 7.25 per cent.

SCOTLAND.

(From our own Correspondent.)

Quieter Outlook.

THE continued advance in prices of steel and iron, owing to heavier costs of raw materials, including fuel, has already had a restricting influence on buying. There are, of course, one or two exceptions, but most classes of material have now more inquiries than firm orders, and though the deliveries named may be favourable enough, the prices quoted are somewhat beyond the ideas of consumers. Therefore, despite the continuance of conditions on the Continent which are calculated to divert orders to local producers, much quieter times are promised with the rise in values. Continental demands for fuel have meant higher prices to home industries, and have thereby imposed a heavy addition to production costs, and thus, though the coal exporter may benefit, the home producer must suffer in the long run. Higher prices have already affected the shipbuilding trade, while general engineering concerns find recent tenders for contracts almost invariably too high. In the meantime, it seems as though conditions are slowly drifting back to what they were not so long ago, when prices were practically on a prohibitive basis, and works were only kept open with the greatest difficulty. Cheaper fuel and imported raw materials are necessary to bring prices to a marketable level. Meantime, the development in industrial circles so recently begun is in danger of serious curtailment.

Strong Market for Pig Iron.

The output of pig iron continues on restricted lines and easily disposed of. Home demands for hematite have been better and foundry qualities have also had more attention. On the other hand, the export inquiry has slackened off. The scarcity of supplies and the cost of output keep the price at a high level with the tendency, still upwards, and it is doubtful if local demands will expand further.

Finished Steel and Iron.

In the finished steel and iron markets generally the predominance of inquiries over firm orders is the outstanding feature. Where a few weeks ago consumers were inclined to anticipate requirements, there is now instead a distinct tendency to entertain only immediate requirements and the lowest minimum at that. Even though the tendency of prices is upward, consumers cannot afford to contract ahead at the present level of charges. The steel works are fairly well occupied with orders at present. Sectional material has been well bought, and sheet rolling mills also have a good quantity of work on hand. Steel sheets have been advanced 10s. per ton all round. Bar iron makers also have been obliged to increase their prices 10s. per ton, and the basis is now £12 10s. per ton for Crown quality bars. Re-rolled steel bars and strips have a good market. Steel tubes have had a promising year and prospects are still favourable.

Scarcity of Coal.

Owing to the heavy export bookings, the scarcity of prompt coal continues, and business in the markets has been reduced almost to negotiations for second-hand lots. Shipments are very heavy, but the congestion at the East of Scotland ports is still very pronounced, and exporters have serious problems to face in the nature of heavy demurrage charges. It is said that at Bo'ness alone there are twenty-two steamers on loading turn. Germany, France and Belgium still take the bulk of the cargoes, and out of 80,000 tons shipped from Methil, fully 50,000 tons went to the first-named. Aggregate shipments for the week amounted to 386,579 tons, against 388,488 tons in the preceding week and 252,913 tons in the same week last year. Outputs are so fully accounted for that some prices have been increased some 2s. 6d. per ton. Industrial orders, therefore, are further curtailed. Export prices generally show little change, though of late it appeared likely that cheaper quotations would be announced.

Coal Prices.

Speaking at a company meeting a day or two ago, a prominent Scotch colliery official, referring to the price of coal, said that apart from the situation in the Ruhr, the high level of quotations was influenced by the world shortage of fuel, accentuated by a lower percentage of output. The output for Britain was between 10,000,000 and 11,000,000 tons short of the output in 1913, although 40,000 more persons were employed in the industry.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE steam coal trade is in an abnormal condition, and is likely to continue so for practically the remainder of this month. It will take fully this time if not longer to recover from the effects of the holidays and the stoppage of work in the Rhondda district, which meant that 30,000 to 40,000 men were idle, and that there was a loss of output of at least 120,000 to 130,000 tons on this account alone, while the coal produced in this area is, of course, the best quality and most in demand. The cost entailed by the suspension of work during the whole of last week by the miners in the Rhondda is difficult to assess with any accuracy, but at least over £100,000 would have been available for distribution as profits and wages, and when account is taken of the loss of wages in respect of the workers at the docks and the cost of keeping tonnage idle, it would seem that the aggregate amounts to round about £250,000. At one time last week there were about 200 steamers taking all the docks in this district, which were waiting to get into loading berths, and it is extremely probable that many of them will not load and sail before the end of the month. Coals of all descriptions are very scarce, and collieries cannot entertain any fresh business for this month, as the majority of them are so much in arrear with their commitments. In the case of the concerns producing the superior classes of coal, it is questionable whether they can undertake any new orders before the middle of May.

Rhondda Miners' Strike.

At one time last week it looked as if the strike of the miners in the Rhondda would run into this week, but on Saturday the men decided to resume work, on which day fully 90 per cent. of the men were back at the pits. The Cambrian men were particularly desirous of getting back to employment, and this no doubt largely influenced the delegates in coming to the decision they did, while it is not impossible that the intimation from wholesale firms to retailers that all orders must be accompanied with cash, with the result that the retailers had no alternative but to stop credit had some weight with the miners. The report of the miners' agents to the executive Council of the Federation on Monday regarding the campaign against the non-unionists was described, according to the official account as "highly satisfactory," but while it is true that non-unionists rejoined the Federation in large numbers, and that the colliery owners assisted to a material extent by advancing money at the colliery offices to men who had not sufficient money to pay their arrears, there is reason to believe that the Federation leaders failed in their campaign against the Mechanical Workers' Union. The miners' leaders at the beginning of the stoppage, declared that there would be no resumption of work until the members of the Mechanical Workers' Union had returned to the Federation, but the craftsmen and surface workers refused to desert their organisation. In the case of the Nine Mile Point Colliery, which has been idle now for about nine weeks, the Federation has voted further financial assistance to its members in their fight against "the few members of the Mechanical Workers' Union."

"Follow-on" System to Terminate.

The announcement is made by the chief docks manager of the Great Western Railway Company for this district, that the practice known as "follow-on" at the coal-tipping appliances at the Bute Docks and Penarth will be discontinued as and from May 1st next, and whilst it is necessary in the general interest that reasonable discretion in the allocating of tips should be exercised by the management, the general governing factors will be priority of stem, coupled with order of arrival in dock of steamers; readiness of vessels to load, and a sufficiency of coals available to maintain reasonably continuous loading; suitability of berth, regard to colliery position, and regard to general cargo vessels and liners requiring bunkers. The change in the system has occasioned no surprise, as the matter had been discussed last November and again last month at meetings between the representatives of the Great Western Railway officials and the traders. The follow-on system has been in operation for years, and at various times has brought forth protests on the score that it was most inequitable, and that the best was not made of the coal-tipping appliances at the docks, inasmuch as tips were "nursed" by the large firms, while it not infrequently happened that steamers came into dock and went into berth, while other steamers might have been in dock days before and were unable to load. It is claimed for the new system to come into operation next month, that better loading results will be obtained, but results alone will prove this. The new system does not so far apply to Barry Docks, where leases of certain tips are in operation; but it is understood that the Great Western Company has under consideration the termination of these agreements.

Ebbw Vale Steel Works.

Nos. 3 and 5 blast-furnaces at Victoria, belonging to the Ebbw Vale Steel, Iron and Coal Company were successfully blown in on Saturday last, the result being that there are now three blast-furnaces in commission, and the steel works plant will restart in the near future. This is welcome news to Ebbw Vale, as it will mean that some hundreds of men will find employment immediately, while the number will be increased in the iron and steel department almost daily. The two furnaces which have been started are among the most up to date in the country. No. 5 was built during the war and is quite new, being a companion furnace to No. 4, which at the time was known as Marine Point Furnace. This is the first time that No. 5 has been put into commission.

De-tinning Works Deal.

It is reported that the de-tinning works of the Welsh Metals Extraction Company, Limited, at Morfa, Llanelly, have been acquired by Mr. Evan Jones, of The Plas, Trimsaran, Llanelly, who is a well-known colliery owner. The cost of the works where the most up-to-date machinery is installed, is estimated at £100,000. The works were competed about twelve months ago, but have not so far begun operations.

Current Business.

The steam coal market is very firm, but it is very difficult to gauge values for prompt loading, for the reason that the amount of business actually being done is so small, since collieries have no coals to spare. The majority of undertakings are very backward in their deliveries, and have much tonnage in dock which they have to load. Superior qualities are regarded as practically out of the market for the whole of this month and the early part of next. Nominally prices for best Admiralty large are in the neighbourhood of 40s. to 42s. 6d., and for superior steam smalls one or two of the collieries are asking as much as 35s. for supplies delivered during the remainder of this month. Small coals of all descriptions are extremely scarce. Coke values show no falling off, and patent fuel, which meets with a better inquiry, is firmly quoted at from 42s. 6d. to 50s. Anthracite coals are very steady.

Third Shift Inquiry.

The Court of Inquiry appointed by the Ministry of Labour to consider the question of the necessity of a third shift at South Wales docks opened on Monday at Cardiff under the presidency of Mr. J. A. Compston, K.C. Sittings also took place on Tuesday and Wednesday, when evidence from the employers' side was taken, after which the inquiry was adjourned until Thursday of next week to enable the workmen's side to prepare their case.

Swansea Metal Exchange.

The tin-plate market is firm and unchanged, though following the holidays the export demand is not quite so active. Production from the mills is increasing, the output being in excess of the pre-war average figure of 1½ million boxes per month, though fewer mills are working.

CONTRACTS.

HOLLINGS AND GUEST, Limited, of Birmingham, are supplying a large complete plant of hydraulic bending presses, pumps and accumulator to the Butterley Company, Limited, Codnor Park Ironworks, Nottingham, for the manufacture of colliery wagons and general wagon work.

THE FULLER ENGINEERING COMPANY has recently received orders for twenty-seven of its Fuller-Lehigh pulveriser mills of various sizes; for several of its Fuller-Kinyon conveying systems; and for seven plants for pulverising, conveying and burning coal, and varying in capacity from 120 to 440 tons per day.

MELDRUMS, Limited, have recently supplied forced draught furnaces to three tar distilleries, three gasworks, a dyeworks, a tannery, a municipal technical college, a Corporation chemical works, two engineers, a waterworks (five boilers), three laundries, an Indian spinning mill, a contractor for drying tar-macadam, and to a steel works for two reverberatory furnaces (repeat). The firm has also supplied refuse destructors for a hospital, an Urban District Council, and a mineral water manufacturer.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are asked by Muntz's Metal Company, Limited, to state that Mr. Charles Bright has been appointed a London director of that company.

THE SELBY ENGINEERING COMPANY, Limited, of 92, Fenchurch-street, London, E.C. 3, informs us that it has recently been appointed by the Navaline Manufacturing Company, of Rotterdam, sole agent for the sale of "Navaline" Lacpaint.

WE are informed by Messrs. C. S. Meik and Buchanan, of 16, Victoria-street, Westminster, London, S.W. 1, that they have taken into partnership Mr. W. T. Halcrow, M. Inst. C.E., who joined the late firm of Thomas Meik and Sons, as a pupil, twenty-three years ago. The firm will continue to be known as C. S. Meik and Buchanan.

THE HEAT TREATMENT OF METALS AND ALLOYS.—The Department of Metallurgy at the Sir John Cass Technical Institute, Jewry-street, Aldgate, E.C. 3, has arranged for a course of instruction in "The Heat Treatment of Metals and Alloys," to be given by Dr. O. F. Hudson, A.R.C.S. This course is arranged for those interested in the after-treatment of manufactured iron and steel and the principal industrial alloys, especially for those engaged in the motor car, aeroplane and similar industries. The course will be held on Tuesday evenings, from 7 to 10 p.m., commencing Tuesday, April 17th, 1923, and will consist of seven lectures followed by demonstrations and practical work in the metallography and testing laboratories. The following is a syllabus:—(a) The applications of heat treatment to iron and steel and non-ferrous metals and alloys. (b) The operations of annealing, hardening, tempering, case-hardening, &c., and the changes in properties thereby produced in ferrous and non-ferrous metals and alloys. Types of furnaces and control of operations. (c) The laboratory work will include experiments in the effect of annealing, hardening and tempering on the mechanical properties of steels, and the metallographic examination of heat-treated specimens. Further particulars may be obtained on application to the Principal, at the Institute.

Current Prices for Metals and Fuels.

IRON ORE.

N.W Coast—	
Native	26/-
(1) Spanish	24/-
(1) N. African	24/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	25/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	6 7 6	—
No. 1 Foundry	6 5 0	—
No. 3 Foundry	6 0 0	—
N.E. Coast—		
Hematite Mixed Nos.	6 7 6	6 7 6
No. 1	6 8 6	6 8 6
Cleveland—		
No. 1	6 12 6	6 12 6
Silicious Iron	6 12 6	6 12 6
No. 3 G.M.B.	6 7 6	6 7 6
No. 4 Foundry	6 5 0	6 5 0
No. 4 Forge	6 0	6 0 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge *	—	—
" " Foundry	5 12 6 to 5 15 0	
(3) Northampton—		
Foundry No. 3 *	—	—
" Forge *	—	—
(3) Derbyshire—		
No. 3 Foundry	5 10 0	—
Forge	5 0 0 to 5 5 0	
(3) Lincolnshire—		
Basic (none offering)	6 0 0 to 6 10 0	
Foundry	5 10 0	—
Forge	5 5 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	7 2 6	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 10 0	—
Best "	—	—
N.E. Coast—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 15 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 10 0	—
Best "	13 10 0	—
Hoops	15 10 0	—
Midlands—		
Crown Bars	12 10 0	—
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	11 10 0 to 11 15 0	
Gas Tube Strip	12 10 0 to 13 10 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates ¾in. and up	9 15 0	-
Sections	9 5 0	—
Steel Sheets ⅛in. to ½in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 10 0

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 0 0	—
Joists	10 0 0	—
Heavy Rails	10 10 0	—
Fish-plates	14 10 0	—
Channels	9 5 0	—
Hard Billets	10 15 0	—
Soft Billets	10 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	10 5 0	—
Light "	13 0 0	—
Billets	11 0 0	—
Manchester—		
Bars (Round)	12 0 0	—
" (others)	11 0 0 to 11 5 0	
Hoops (Best)	15 5 0	15 0 0
" (Soft Steel)	13 15 0	13 10 0
Plates	11 0 0 to 11 10 0	
" (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	13 0 0	—
Bessemer Billets	13 10 0	—
Hard Basic	10 15 0	—
Intermediate Basic	10 10 0	—
Soft Basic	10 0 0	—
Hoops	12 15 0 to 13 5 0	
Soft Wire Rods	13 0 0 to 13 10 0	
Midlands—		
Small Rolled Bars	12 0 0	—
Billets and Sheet-bars	9 15 0 to 10 0 0	
Gas Tube Strip	12 0 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	19 10 0 to 19 15 0	
Angles	10 10 0	—
Joists	10 10 0	—
Tees	11 10 0	—
Bridge and Tank Plates	10 15 0 to 11 0 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	25/- to 25/6
Block Tin (cash)	215 0 0
" (three months)	215 15 0
Copper (cash)	78 7 6
" (three months)	74 5 0
Spanish Lead (cash)	27 15 0
" (three months)	27 12 6
Spelter (cash)	34 18 9
" (three months)	34 18 9
Manchester—	
Copper, Best Selected Ingots	78 10 0
" Electrolytic	82 0 0
" Strong Sheets	106 0 0
" Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 1
" Condenser	0 1 2½
Lead, English	29 0 0
" Foreign	28 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/6
" 6 p.c. to 8 p.c. "	£21 0 0	8/-
" 8 p.c. to 10 p.c. "	£20 0 0	8/-
" Specially Refined		
" Max. 2 p.c. carbon	£52 0 0	20/-
" " 1 p.c. "	£62 0 0	22/6
" " 0·75 p.c. carbon	£72 0 0	25/-
" carbon free	1/6 per lb.	
Metallic Chromium	4/6 per lb.	
Ferro Manganese (per ton)	£16 for home.	
" Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
" " 75 p.c.	£21 0 0 scale 6/- per unit	
" Vanadium	17/- per lb.	
" Molybdenum	9/6 per lb.	
" Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£130	
Cobalt	12/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	27/-
" " Ell	29/-
" " Splint	31/- to 35/-
" " Trebles	30/6
" " Doubles	30,3
" " Singles	30/-
Ayrshire—	
(f.o.b. Ports)—Steam	27/-
" " Splint	31/-
" " Trebles	30,6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	28/- to 33/-
Screened Navigation	36/-
Trebles	31/-
Doubles	30/6
Singles	30/-
Lothians—	
(f.o.b. Leith)—Best Steam	30/6
Secondary Steam	28/-
Trebles	31/-
Doubles	30/6
Singles	30/-

ENGLAND.

(8) N.W. Coast—	
Steams	31,6
Household	46/8 to 57/6
Coke	48/-
Northumberland—	
Best Steams	33/6 to 35/-
Second Steams	31/- to 32,6
Steam Smalls	23/- to 25/-
Unscreened	20/6
Household	25/- to 28/-
Durham—	
Best Gas	33/- to 35/-
Second	32/6
Household	25/- to 28/-
Foundry Coke	75/- to 77/6

Sheffield—	Inland.
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	25/6 to 27/6 —
" " House	23/- to 24/6 —
" " Large Nuts	20/6 to 22/6 —
" " Small "	17/- to 19/- —
Yorkshire Hards	22/- to 24/- —
Derbyshire "	21/- to 24/- —
Rough Slacks	12/- to 14/- —
Nutty "	10/6 to 12/6 —
Smalls	7/- to 9/- —
Blast Furnace Coke (Inland)	24/- to 27/-
" " " (Export)	44/- to 47/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	42/6 to 45/-
Second " "	40/- to 42/6
Best Dry Large	40/- to 42/6
Ordinary Dry Large	37/6 to 40/-
Best Black Vein Large	40/- to 42/6
Western Valley "	37/6 to 40/-
Best Eastern Valley Large	37/6 to 40/-
Ordinary " "	33/- to 35/-
Best Steam Smalls	30/- to 32/6
Ordinary "	25/- to 30/-
Washed Nuts	30/- to 35/-
No. 3 Rhondda Large	40/- to 42/6
" " Smalls	30/- to 32/6
No. 2 " Large	32/6 to 35/-
" " Through	30/- to 32/6
" " Smalls	25/- to 27/6
Coke (export)	70/- to 80/-
Patent Fuel	42/6 to 50/-
Pitwood (ex ship)	29/6 to 30/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	45/- to 46/-
Seconds	40/- to 42/6
Red Vein	30/- to 32/6
Machine-made Cobbles	47/6 to 50/-
Nuts	50/- to 52,6
Beans	45/- to 47/6
Peas	23/- to 25/-
Breaker Duff	12/- to 13/-
Rubbly Culm	17/- to 17,6
Steam Coals:	
Large	29/- to 31/-
Seconds	26/- to 27/-
Smalls	19/- to 21/-
Cargo Through	23/- to 25/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal.

French Engineering Notes.

(From our Correspondent in Paris.)

Ruhr Coke.

By taking possession of coke ovens in the Ruhr, seizing stocks estimated at more than half a million tons, and organising services of trains with the aid of French railwaymen, the army of occupation has succeeded in rapidly increasing the consignments of coke until the quantity sent daily into France is now about 4000 tons. It is stated officially that by the end of the month the Ruhr will be supplying French blast-furnaces with more than a quarter of a million tons of coke monthly, but this will necessarily depend upon the readiness of German labour to keep the ovens going, and for the moment the Germans, while refusing to work in the presence of the French, are not turning out anything like a normal production when left to themselves. The French authorities are apparently making vain efforts to combat the ca' canny spirit which is resulting in a considerable diminution in the output of coal and coke. For the time being, at any rate, the supplies of coke are allowing of many furnaces being put in blast. While the immediate effect has been to relieve the situation of the iron and steel trades, it will be some time before raw material can become fairly abundant. As soon as the arrival of Ruhr coke seemed to put an end to the crisis, orders were plentiful in the engineering industries, especially on account of public works and reconstruction, and a remarkable feature has been the steady progress in business done abroad, although it will probably be found that the increase in the exports of manufactured goods, from 292,913 tons during the first two months of 1922 to 446,821 tons in the corresponding period of the present year, relate more particularly to products outside the metallurgical and engineering trades. The remarkable improvement in the foreign trade nevertheless had the effect of inspiring confidence, which, however, has not been maintained, and during the past week a reaction has set in that can only be attributed to an impression that the putting of furnaces in blast will bring down iron and steel prices.

Reconstruction.

The impression that has been entertained in some quarters that the work of reconstruction in the devastated areas has been purposely retarded is dispelled by recently published statistics showing what has been done up to the beginning of the present year. It appears from these figures that of the 741,993 houses demolished or damaged during the war, 553,977 had been rebuilt or repaired. Of the 22,900 works and factories destroyed 19,967 had been reconstructed, while 32,650 kiloms. of road were re-laid out of a total of 58,697 kiloms. The number of bridges and other engineering works destroyed was 6123; at the beginning of the year 5189 were reconstructed. It is interesting to note that 287,200,815 cubic metres of barbed wire have been removed and that 1,035,200 live shells left on the battlefields were destroyed. The same progress is observable in the area of land under cultivation, while 280,102,300 cubic metres of trenches have been filled in. The inhabitants have been returning to the devastated regions, until their number is not very far short of the pre-war total of 4,690,000. The State has already advanced 49,000 million francs on account of damages estimated at 102,000 million francs, but as no more funds are available the work of reconstruction is practically suspended until reparations can be obtained from Germany.

Cheap Flight.

In carrying out experiments with gliders it has been argued that in designing apparatus capable of manœuvring in air currents great progress must necessarily be made in planes offering the least possible resistance to flight, and at the same time providing the necessary lifting power. If a plane can glide with the effect of its own momentum down an incline and remain in the air an appreciable time it was supposed that very little power would be needed to enable the apparatus to fly independently of air currents. The experience thus gained would permit of the development of a new type of light aeroplane of cheap construction which would entirely solve the problem of flying at low cost. Until last week all efforts in this direction had failed to give appreciable results, and revived interest is therefore being taken in the glider following upon the successful flight of Barbot on a Dewoitine apparatus fitted with a 7 horse-power engine. It is stated that Barbot started his flight unaided and remained in the air at a uniform altitude of 50 m., there being at the time practically no wind. A subsequent flight was made at a greater altitude. It is claimed that this is the first time that an aeroplane of such low power has been successfully navigated, and if the results should be confirmed they will at least open the way to the evolution of a type of machine capable of flying at an extremely low cost per mile. Following upon these experiments, a prize has been offered to the first pilot making a return flight across the Channel with a petrol consumption of not more than three litres, which means that the engine would have to be something like that fitted to a powerful motor bicycle.

State Electrification.

Although the State has no intention of claiming any monopoly of electrification, it has nevertheless found it necessary to control and assist financially the various big enterprises which are to be left in the hands of the departments, communes and other groups sharing with the State the guarantee of capital. It does not interfere with concessions like that of the Upper Dordogne, which has been made over to the Paris-Orleans Company for railway electrification, but the utilisation of the Middle Dordogne by a company in which the State will have a preponderating interest is to be sanctioned by a Bill which has just been introduced into the Chamber of Deputies. Besides supplying current to a vast agricultural region, the scheme aims at distributing electricity to a large number of industrial centres, such as Montluçon and Clermond-Ferrand. The annual output is estimated at 600 million kilowatt-hours.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

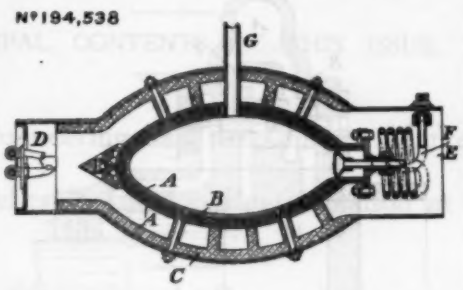
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

194,538. March 8th, 1922.—FLASH BOILERS, B. J. N. Marden, Stodham Park, Liss, Hants.

The inventor proposes to make the shell of the boiler of double plates, and to fill the intervening space with lead, so that when the demand for steam is reduced the lead will absorb the heat

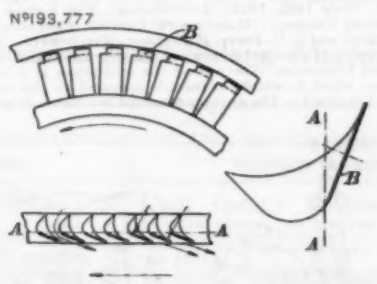


from the burner and store it for subsequent use. The double shell is shown at A A, and the lead filling at B. C is the fire-brick casing, while D is the oil burner, E the flue, and F a feed heater. The steam outlet is marked G.—*March 15th*, 1923.

TURBINE MACHINERY.

193,777. July 10th, 1922.—STEAM TURBINE BLADING, Aktiebolaget Ljungströms, Angturbin, Arsenalsgatan 2, Stockholm, Sweden.

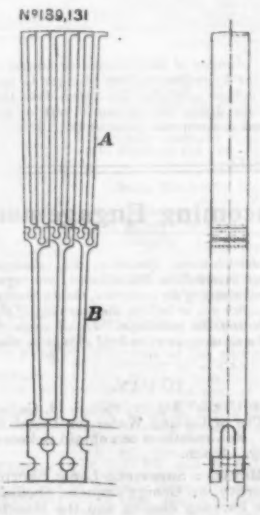
The inventors propose to provide a thin edge on radial blading, so that the clearance space may be reduced to a minimum, and if the edge happens to touch the casing it will be rubbed away without damage to either part. This thin edge is produced by



turning down the ends of the blades, after they are assembled in the rotor, as far as the line A A. The triangular projections left on the ends of the blades are then reduced to a narrow strip B, by filing, which can safely be allowed to rub against the casing.—*March 1st*, 1923.

189,131. November 14th, 1922.—LOW-PRESSURE BLADING Société Rateau, 40, Rue du Colisée, Paris.

In the low-pressure rotors of large turbines it has been found necessary to employ blades of considerable radial length, in order to obtain sufficient clearance area, with the result that when the circumferential distance between the axes of adjacent blades at the mean of their length is a suitable one, this distance becomes too small at the bases of the blades to allow them to be attached securely to the

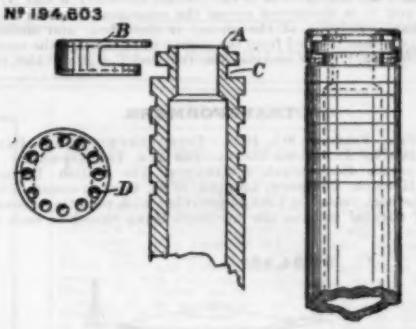


periphery of the disc or hub, whilst at the other extremities of the blades, it is too great for the steam to act upon them without considerable waste. According to this invention, and with a view to increasing the radial dimension of the steam passages, the single stream of steam in the low-pressure stages of a turbine is divided into two or more streams flowing in the same direction and at the same pressure between crowns of blades, of which the outer blades A are mounted on the ends of the inner blades B. —*March 1st*, 1923.

PUMPING AND BLOWING MACHINERY.

194,603. May 31st, 1922.—REFRIGERATOR COMPRESSORS, A. E. Hefford and R. Searle, Stanbury Works, Stanbury-road, Peckham, London, S.E. 15.

This invention is concerned with the inlet valves of small compressors for CO_2 refrigerating machines. The piston is made hollow, and admission is effected through it from below. The head of the piston is provided with a seating A. The valve

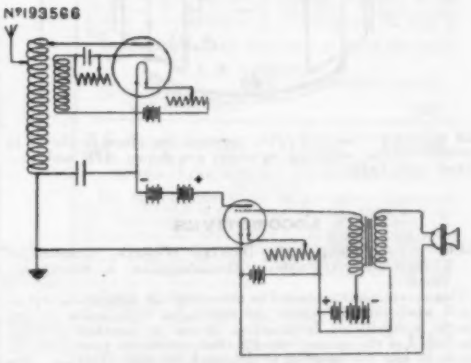


B takes the form of a disc with a horse-shoe shaped extension that is sprung into the groove C. The clip is free to move axially within the groove, to allow the valve disc to lift off its seating, while the disc is perforated, as at D, to permit the passage of the gas.—*March 15th*, 1923.

TELEGRAPHS AND TELEPHONES.

193,566. September 14th, 1922.—IMPROVEMENTS IN THE CONTROL OF VALVE TRANSMITTERS, André Onwood, of 30, Hambledon-road, Southfields, S.W. 18.

According to this invention, the filament battery of the auxiliary control valve and the apparatus in the circuit of the microphone or signalling key used to control the grid potential of the control valve are provided with a connection to an earthed terminal of the receiving apparatus, so as to be main-

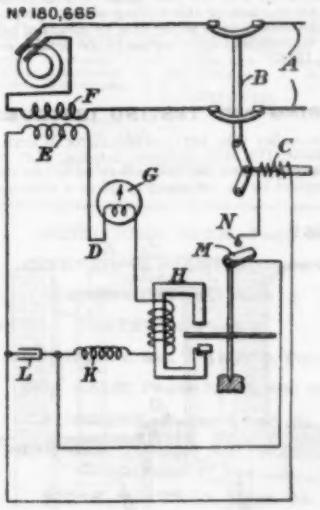


tained at earth potential. The connections are clearly shown in the diagram, and scarcely call for a detailed description. In order to enable the invention to be carried out, it is preferable to connect the anode of the control valve to the positive terminal of the source of supply delivering energy to the main power or oscillating valve and to connect the filament of the control valve to the anode of the main power valves.—*March 1st*, 1923.

SWITCHGEAR.

180,665. May 14th, 1922.—IMPROVEMENTS IN OR RELATING TO ELECTRICAL PROTECTIVE SYSTEMS. *The Metropolitan Vickers Electrical Company, 4, Central Buildings, Westminster.*

A resonant circuit is connected to a current transformer, and upon the occurrence of abnormal conditions in the circuit to be protected, the trip coil is connected across the reactive elements of the resonant circuit. Upon the occurrence of abnormal conditions in the circuit A, the circuit breaker B is actuated by a tripping mechanism C, the mechanism being



energised by a relay tripping system D. This relay system comprises the secondary winding E of a current transformer, the primary winding F of which is connected in the main circuit. The secondary winding E is connected in circuit with the winding of an electrical instrument G, the winding of a relay H, an inductive reactance K, and a capacity reactance L. The

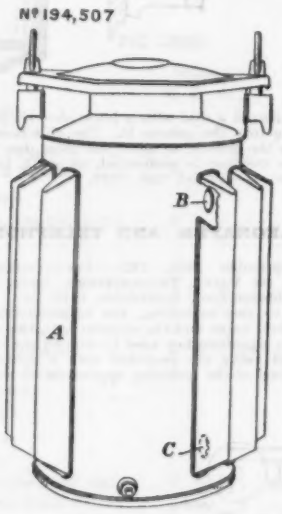
relay is preferably of the induction disc type with an inverse time element, and when energised to a predetermined degree is adopted to engage a pair of contact members M and N. The instrument G and relay H serve to increase the value of the inductive reactance of the relay system, and, if desired, may be arranged to constitute the entire inductive reactance. The reactive elements G, H, K and L are arranged with respect to the current transformer and the other elements included in the circuit, so that the circuit is normally resonant. Upon the occurrence of abnormal conditions in the circuit A, sufficient to effect the engagement of the contact members M and N, the trip coil C is connected across the reactance, whereupon the resonant condition of the circuit is disturbed, and sufficient energy is then derived from the main circuit through the current transformer E F to energise the trip coil C.—*March 15th*, 1923.

TRANSFORMERS.

194,507. February 8th, 1922.—Improvements in and Relating to Tanks or Containers for Transformers and other Electrical Apparatus, The British Thomson-Houston Company, Limited, of 83, Cannon-street, E.C. 4.

The heat radiating tank is provided with radiating members A of channel section, the members being closed at each end

No 194,507



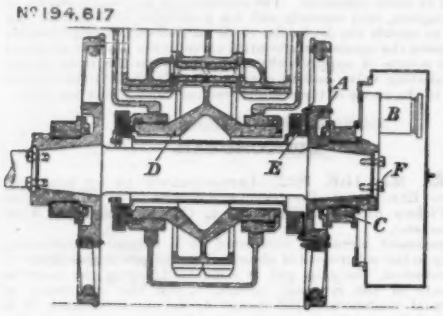
and welded to the tank. Oil passages for allowing the oil to circulate in the radiating members are shown at B and C.—*March 15th*, 1923.

LOCOMOTIVES.

194,617. July 28th, 1922.—Driving Wheels, Aktiebolaget Ljungströms Angturbin, Arsenalsagatan 2, Stockholm, Sweden.

This invention is intended to overcome the difficulties experienced when outside cranks are associated with inside driving wheels, specially on locomotives driven by toothed gearing. The hub A of the driving wheel is thus cast in one piece with the crank B, and the journal C arranged between the two. The

No 194,617



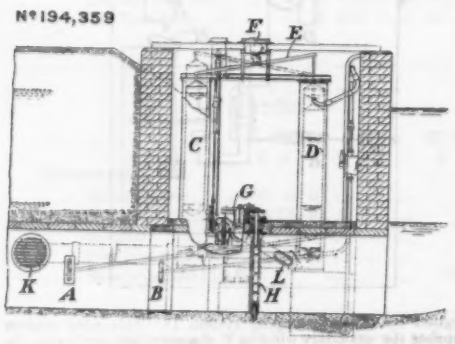
drive is transmitted from the gear wheel D, through the flexible coupling E, to the hub of the driving wheel. The wheels are secured on the conical ends of the axle by means of bolts F, and can thus be dismantled to give access to the flexible coupling.—*March 15th*, 1923.

MEASURING AND TESTING INSTRUMENTS.

194,359. December 9th, 1921.—Irrigation Water Meters, W. G. Kent, 199, High Holborn, London, W.C. 1.

This apparatus is intended not merely to record the amount of water supplied by an irrigating canal to a distributory, but

No 194,359



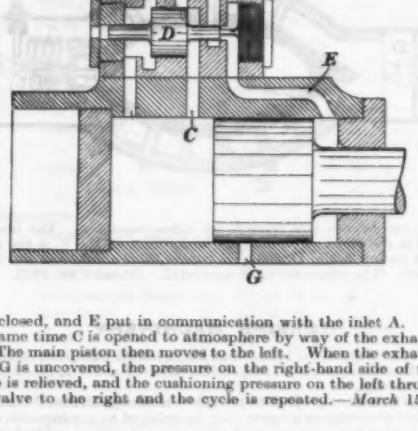
also to maintain a predetermined rate of flow regardless of the water levels in the canal and ditch. The communicating channel is equipped with two Pitot tubes A and B, which are connected with the chambers C and D that contain floats operating the rocking lever E. This lever is used to work the recorder F, and also to control the admission of water to a turbine G that controls the gate valve H. The control apparatus, of which a detailed description is given in the specification, operates the turbine in one direction or the other according to the difference of head. The water for running the turbine is taken from the channel at K and discharged at L.—*March 9th*, 1923.

MINING MACHINERY.

194,632. September 16th, 1922.—Rock Drill Valve Gear, G. H. T. Rayner, 14, Broomhall-road, and P. Rayner, 38, Chantrey-road, Woodseats, Sheffield.

As shown in the illustration, the main piston of this rock drill is approaching the end of its stroke to the right. The air inlet is at A, and the inlet port B is open. When the main piston uncovers the port C air is admitted to the face of the valve D, while the cushioning pressure acts, through the port E on the end of the valve stem. The valve is thus thrown to the left,

No 194,632



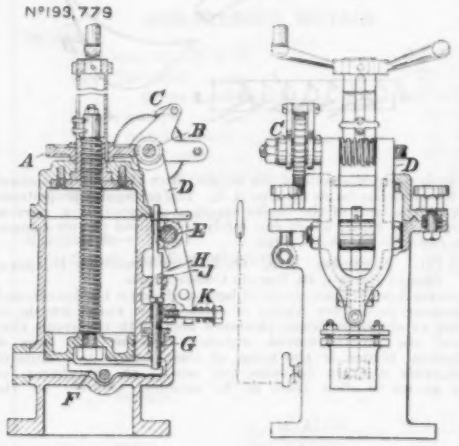
B is closed, and E put in communication with the inlet A. At the same time C is opened to atmosphere by way of the exhaust F. The main piston then moves to the left. When the exhaust port G is uncovered, the pressure on the right-hand side of the valve is relieved, and the cushioning pressure on the left throws the valve to the right and the cycle is repeated.—*March 15th*, 1923.

MISCELLANEOUS.

193,779. July 14th, 1922.—Lubricators, The Empire Engineering Company (Manchester), Limited, Clarendon-road, Salford, and C. H. Berry, Bold-street, Manchester.

This device is intended to prevent the overwinding of a screw force-feed lubricator. The nut on the feed screw is driven by the worm wheel A, which, in turn, is operated by the worm B and ratchet gear C. The worm is mounted in a frame D pivoted

No 193,779



at E. When the plunger of this lubricator comes to the end of its stroke the lever F pushes up the plunger G until the lug H on the frame D comes opposite the notch J in the plunger G. The spring K then draws the worm B out of mesh with its wheel and the feed is stopped.—*March 1st*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Diesel Engine Users' Association.—19, Cadogan-gardens, S.W. 3. "The Use of Cooling Water for Diesel Engines," by Mr. J. G. Griffin. Non-members can obtain tickets of admission from the secretary. 3 p.m.

Institute of Metals: Sheffield Local Section.—Mappin Hall of the University, St. George's-square, Sheffield. Conjoint meeting with the Faraday Society and the Manchester Metallurgical Society. 3 p.m.

Institute of Metals: Swansea Local Section.—University College, Singleton Park, Swansea. Paper, "Casting and Castings," by Professor C. A. Edwards. 7.15 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Paper, "Instrument Equipment of Aeroplanes," by Mr. C. B. Clapham. 7.30 p.m.

London Society.—18, John-street, Adelphi, W.C. 2. Paper, "London's New Trunk Roads in the Making," by Mr. C. H. Bressey. 5 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "Studies from a Wireless Laboratory," by Dr. W. H. Eccles. 9 p.m.

MONDAY, APRIL 16TH.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Nitrates from Air," by Mr. E. Kilburn Scott. 8 p.m.

TUESDAY, APRIL 17TH.

Institute of Marine Engineers.—85–88, The Minories, Tower-hill, E. 1. "The Operation of Water-tube Boilers for Cargo and Passenger Ships," by Mr. R. Clark. 6.30 p.m.

Institute of Transport.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Graduates' and students' lecture, "The Prevention of Traffic Accidents," by Mr. H. E. Blain. 5.30 p.m.

Institution of Civil Engineers.—Great George-street, S.W. 1. Special general meeting of corporate members to approve and adopt revised by-laws. 6 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. Papers, "The Search for Petroleum in England," by Mr. T. Sington, and "The Davy Safety Lamp *v.* the Electric Safety Lamp," by Sir Henry Hall. 3 p.m.

WEDNESDAY, APRIL 18TH.

Institution of Automobile Engineers.—The Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' meeting. Paper, "Jigs and Tools," by Mr. T. V. Skinner. 7.30 p.m.

Institution of Automobile Engineers: Wolverhampton Centre.—The Star and Garter Hotel, Wolverhampton. Paper, "Sleeve Valve Engines," by Mr. E. B. Wood. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, S.W. 1. Students' meeting. Paper, "Pulau Ubin Quarry," by Mr. A. H. Naylor. 6 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "Modern Abattoir Practice and Methods of Slaughtering," by Mr. Hal Williams. 4.30 p.m.

Society of Glass Technology.—The University, St. George's-square, Sheffield. Sixth annual general meeting. 2.30 p.m.

THURSDAY, APRIL 19TH.

Institution of Automobile Engineers.—28, Victoria-street, S.W. 1. London Graduates' meeting. Paper, "Braking Systems," by Mr. D. J. Macklin. 8 p.m.

FRIDAY, APRIL 20TH.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Hardness Tests Research: "Static Indentation Tests," by Mr. R. G. C. Batson, and "The Relation between Width of Scratch and Load on Diamond in the Scratch Hardness Test," by Mr. G. A. Hankins. 6 p.m.

Institution of Civil Engineers: Yorkshire Association.—Philosophical Hall, Leeds. Paper, "Boiler Plant Economy," by Mr. W. M. Hobblethwaite. 7.30 p.m.

Institution of Engineering Inspection.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper, "The Inspection of Ball Bearings," by Mr. C. H. Richardson. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "The Business of Engineering," by Mr. H. L. Munro. 7.30 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Growth of the Telescope," by Mr. W. J. S. Lockyer. 9 p.m.

SATURDAY, APRIL 21ST.

Institution of British Foundrymen: Lancashire Branch.—Visit to the Stanton Ironworks, Nottingham. Train leaves Manchester (Central) at 8.55 a.m.

MONDAY, APRIL 23RD.

Institution of Automobile Engineers.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "Engine Testing," by Mr. H. R. Ricardo. 7 p.m.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Paper, "Sleeve Valve Engines," by Mr. E. B. Wood. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Informal discussion on "Practical Broadcasting," to be opened by Mr. E. H. Shaughnessy. 7 p.m.

TUESDAY, APRIL 24TH.

Institution of Automobile Engineers.—Railway Hotel, Coventry. Paper, "Sleeve Valve Engines," by Mr. E. B. Wood. 7.30 p.m.

WEDNESDAY, APRIL 25TH.

Institution of Automobile Engineers: North of England Centre.—Education Offices, Salford. Papers, "The Steam Wagon from the Designer's Point of View," by Mr. F. J. Bretherton, and "The Use and Limitations of the Steam Wagon," by Mr. C. C. M. Gosselin. 7.30 p.m.

THURSDAY, APRIL 26TH.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. "The Drive of Power Station Auxiliaries," by Messrs. L. Breach and H. Midgley. 6 p.m.

FRIDAY, APRIL 27TH.

Institute of Metals: Sheffield Local Section.—Mappin Hall of the University, St. George's-square, Sheffield. Annual general meeting. 7.30 p.m.

Institution of Electrical Engineers: Scottish Centre.—The Technical Institute, Dundee. Paper, "The Drive of Power Station Auxiliaries," by Messrs. L. Breach and H. Midgley. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Stock Control," by Mr. J. Fearn. 7.30 p.m.

WEDNESDAY, MAY 2ND.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Thirteenth annual May Lecture on "The Inner Structure of Alloys," by Dr. W. Rosenhain, F.R.S. 8 p.m.

THURSDAY AND FRIDAY, MAY 10TH AND 11TH.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting. For programme, see page 401. 10 a.m. each day.